COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

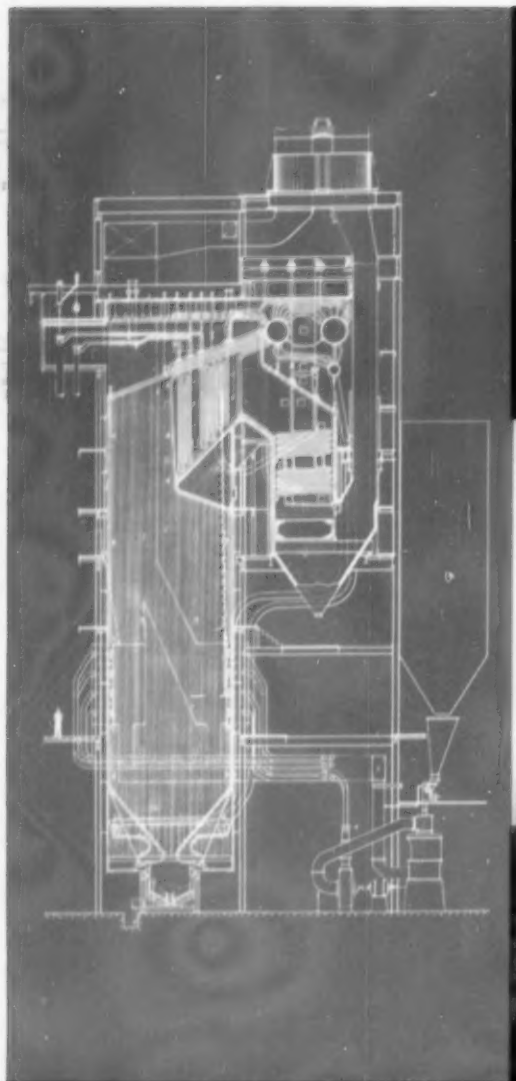
November 1954

Martins Creek Steam Electric Station of Pennsylvania Power & Light Co.: see page 38

Burning Paper Mill Waste Liquors

Continuous Coking Process for Industrials

Fifteenth Annual Water Conference



Performance Record

Lee Steam Station
Duke Power Company

Among the first of the postwar, reheat units to be placed in service were those at the new Lee Steam Station of Duke Power Company.

There are two C-E Radiant Reheat Boilers each designed to serve a 90,000 100,000 kw turbine-generator operating at a throttle pressure of 1250 psi with steam temperature at 950 F, reheated to 950 F.

The most recently available full years performance record for the boilers – for the period Jan. 1 to Dec. 31 1953 – show the following principal results:

AVAILABILITY	**98.38%**
(In service or available. Not considered available while down for inspection or repair or while in process of starting up or shutting down.)	
USE FACTOR	**96.71%**
(Ratio of in-service hours to total hours.)	
CAPACITY FACTOR	**102.70%**
(Ratio of average hourly output – net kw – to nameplate capacity of turbine-generator.)	

COMBUSTION ENGINEERING

Combustion Engineering Building, 200 Madison Avenue, New York 16, N. Y.

C-E

B-787

BOILERS, FUEL BURNING & RELATED EQUIPMENT; PULVERIZERS, AIR SEPARATORS & FLASH DRYING SYSTEMS; PRESSURE VESSELS; AUTOMATIC WATER HEATERS; SOIL PIPE

COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

Vol. 26 **No. 5**

November 1954

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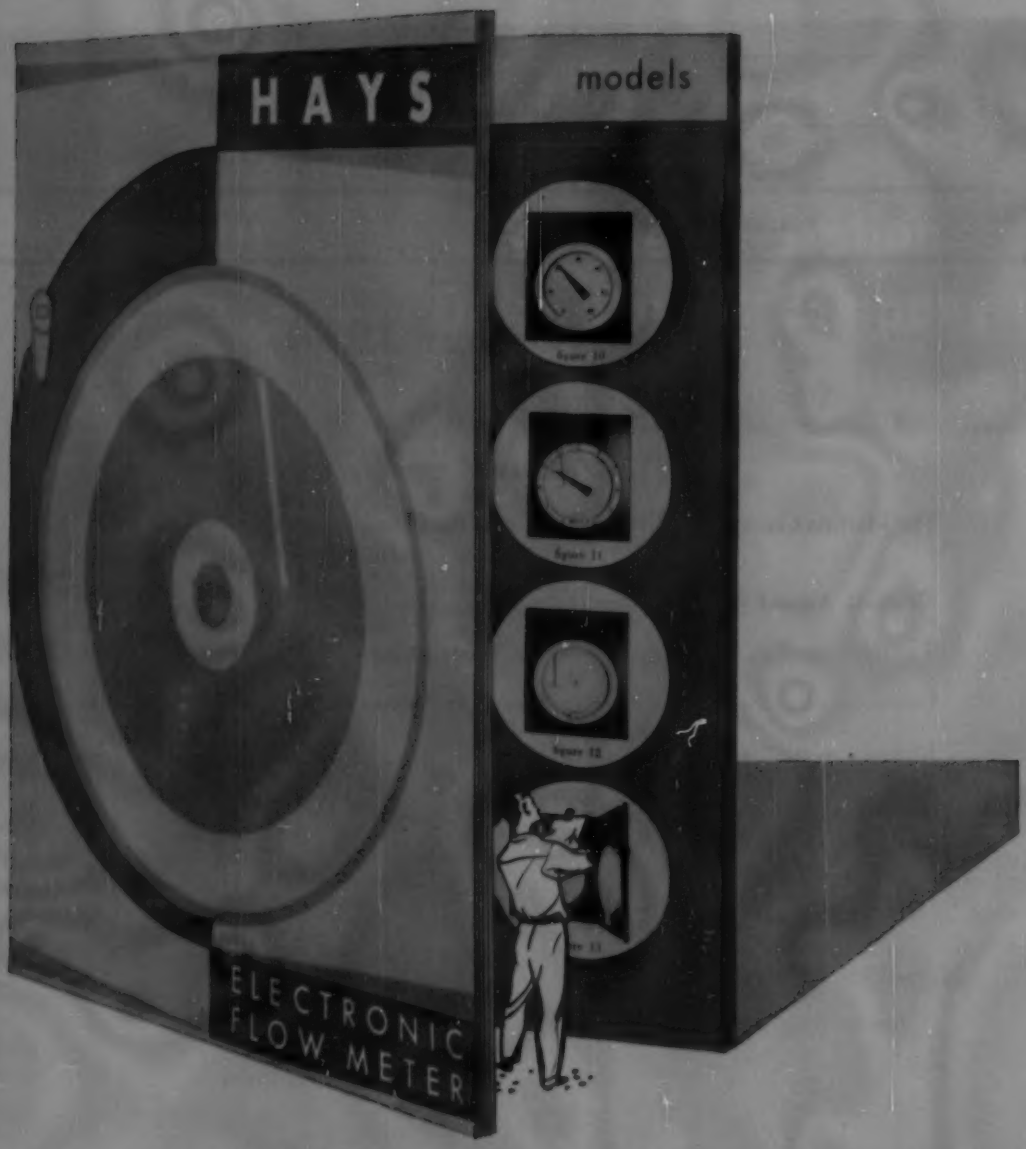

A guide to better flow metering

Here's a new fact-filled, technical booklet that tells you feature for feature how the new Hays electronic flow meter excels.

Electronic operation—provides maximum accuracy (½% of full scale differential), and speed (4 seconds for full scale pen travel).

Mercuryless transmitters—rupture-proof metallic bellows for differential pressure measurement.

Continuous integration—motor-driven, continuous mechanical integrator is extremely accurate even on rapid load changes.

Other features include powerful motor, easy readability, accuracy unaffected by normal temperature changes, optional explosion and weather-proof transmitter.

Write for bulletin 54-1074-222 and get the important facts.

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Boiler Panels • CO_2 Recorders
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Gas Analyzers • Draft Gages
Combustion Test Sets
Electronic Oxygen Recorders
Electronic Flowmeters
Electronic Feed Water Controls
Miniature Remote Indicators

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CORPORATION
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For low-cost, dependable steam, Upjohn burns coal the modern way

Upjohn has long been famous as a manufacturer of pharmaceutical products. Because of the nature of these products, it was necessary that the steam plant of Upjohn's new Portage Road Plant, near Kalamazoo, Michigan, operate cleanly as well as economically. Therefore, coal was chosen to fire its boilers.

Today Upjohn's ultramodern steam plant supplies steam at only 40c to 42c per 1,000 pounds. It is clean and efficient, with no dust or smoke nuisances, and ash handling is fully automatic. At peak load, the three boilers shown above, plus a fourth recently installed, deliver up to 115,000 lbs. of steam per hour.

Investigate Your Fuel Costs

If you're planning to modernize your plant or build a new one—or if you are just interested in cutting fuel costs—find out how coal, burned the modern way, compares to other fuels. Talk to a consulting engineer or your nearest coal distributor. Their advice may save you thousands of dollars every year.

facts you should know about coal

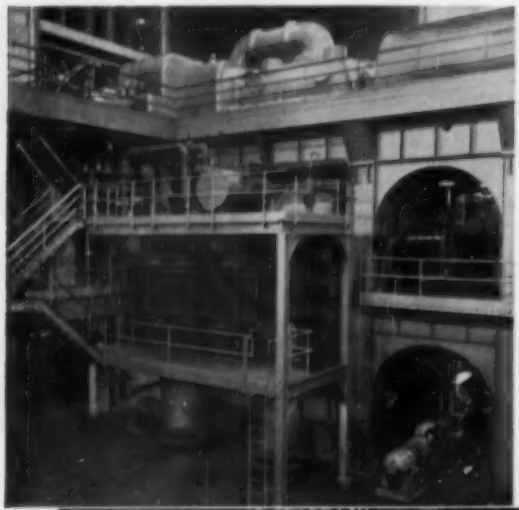
- In most industrial areas, bituminous coal is the lowest-cost fuel available.
- Up-to-date coal burning equipment can give you 10% to 40% more steam per dollar.
- Automatic coal and ash handling systems can cut your labor cost to a minimum.
- Coal is the safest fuel to store and use. No dust or smoke problems when coal is burned with modern equipment.
- Between America's vast coal reserves and mechanized coal production methods, you can count on coal being plentiful and its price remaining stable.

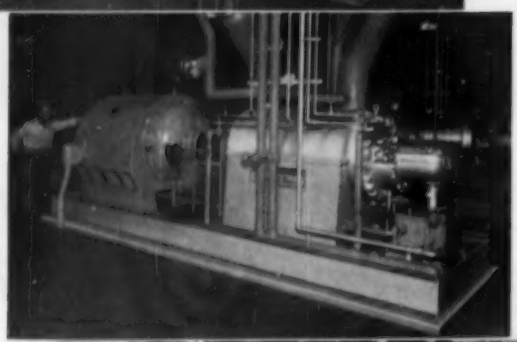
For further information or additional case histories showing how other plants have saved money burning coal, write to the address below.

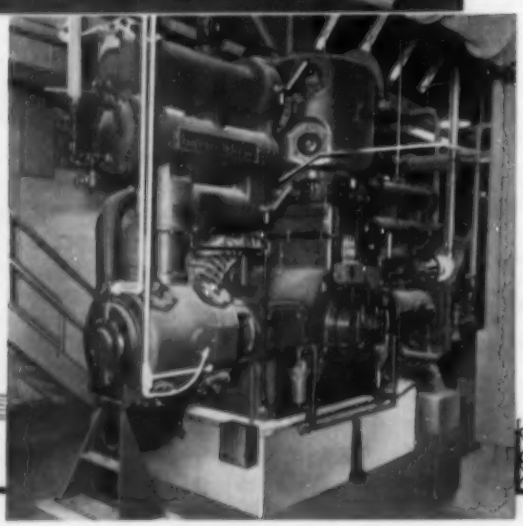
BITUMINOUS COAL INSTITUTE

A department of National Coal Association • Southern Building, Washington 5, D.C.

PROVED DEPENDABILITY
in Power Plant Equipment







Condensers: Surface types for every generating capacity in space-saving rectangular design. Also Disc-Flow and ejector jet barometric condensers and a complete line of I-R auxiliaries, including steam-jet ejectors, vacuum pumps, air leakage meters, circulating and condensate pumps.

•

Boiler Feed Pumps: For all pressures, capacities, and temperatures. Also single and multi-stage pumps for every power plant requirement in centrifugal, mixed and axial flow types.

•

Compressors: Stationary air compressors are available in all sizes and types, either direct connected or belt driven, for soot blowing, instrument air and other power plant services. A complete line of Gyro-Flo portable air compressors in sizes to 600 cfm provide a dependable source of air power for plant construction and maintenance.

•

Ingersoll-Rand's specialized experience in building dependable power plant equipment is at your service. A call or letter to your nearest Ingersoll-Rand office will bring a quick solution to your specific problems. There's no obligation, of course.

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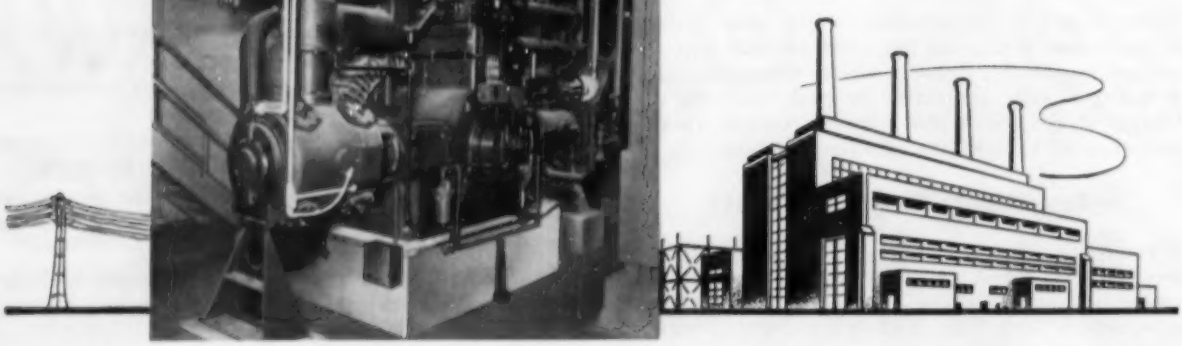

AIR AND ELECTRIC TOOLS • DIESEL ENGINES • PUMPS • CONDENSERS • COMPRESSORS • VACUUM EQUIPMENT

new WIDER VISION

for easier remote boiler water level readings

■ Vastly improved visibility of remote boiler water level readings can now be enjoyed by boiler plant operators.

A new "wide vision" face on Yarway Remote Liquid Level Indicators allows reading from the side as well as front of the indicator. Boiler water levels and other liquid levels can be checked from most any position.

Indicating mechanism is operated by the boiler water level itself—assuring instant, accurate readings.

Yarway Indicators are of the manometric type with automatic temperature compensation, as approved for use under the recent A.S.M.E. Boiler Code Committee ruling in Case #1155.

Over 10,000 are used throughout industry for boiler water and other liquid level indication . . . and for superheater pressure differential indication aboard ship.

For full information write for Bulletin WG-1823.

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101 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

A COMPLETE YARWAY SYSTEM

Besides Remote Liquid Level Indicators, Yarway also offers Liquid Level Recorders and Remote Signal Alarms . . . making a complete system for constant, accurate liquid level check.

■ Yarway Hi-Lo-Graph Recorder provides not only water level indication, but also a 24-hour recording of water levels. See Yarway Bulletin WG-1830.

■ Yarway Remote Hi-Lo-Alarm Signals—lights or horns—can be placed at any location in plant. See Yarway Bulletin WG-1823.

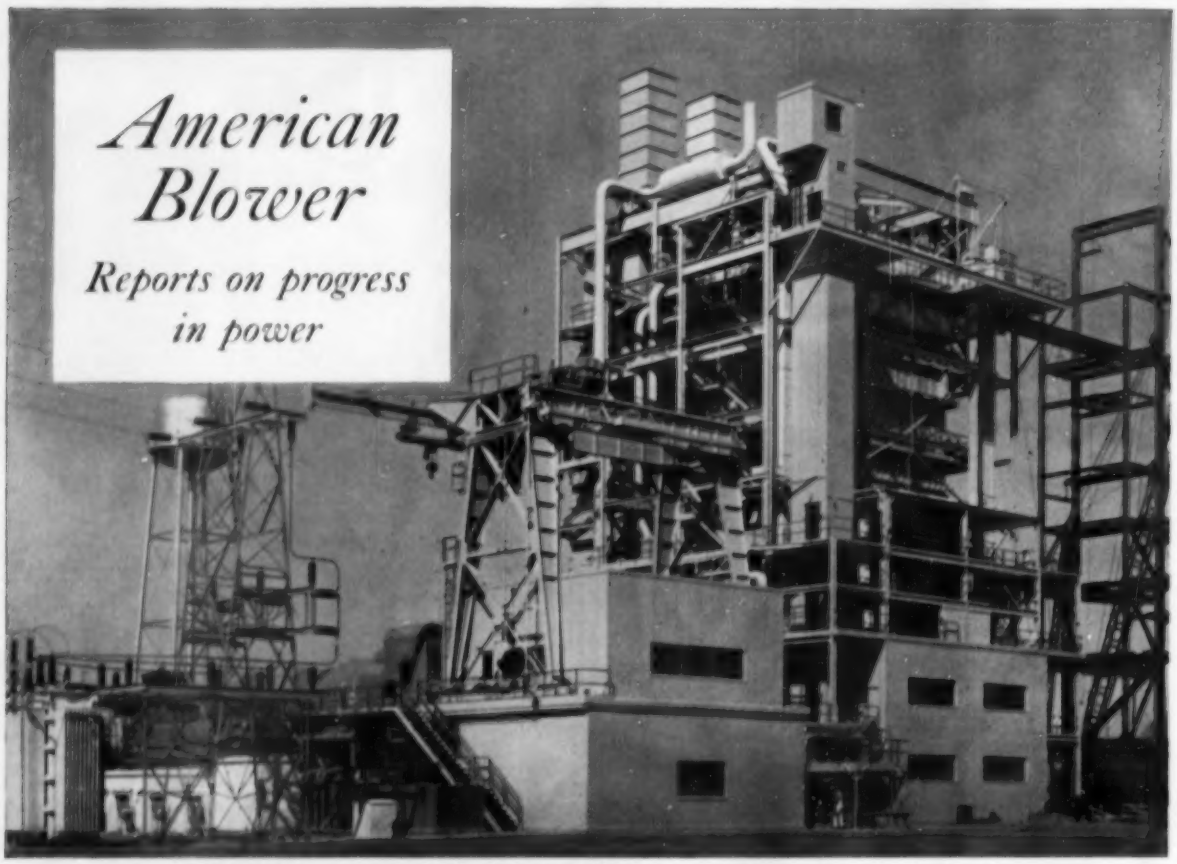
WHAT'S NEW AT YARWAY?

See the Yarway exhibit, Booths: 513–517 at the National Power Exposition in Philadelphia, Dec. 2–7.

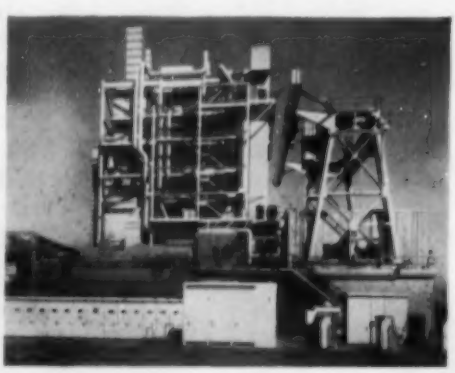
YARWAY

remote liquid level indicators

Dallas Power & Light Co. Sirocco Fans for Parkdale



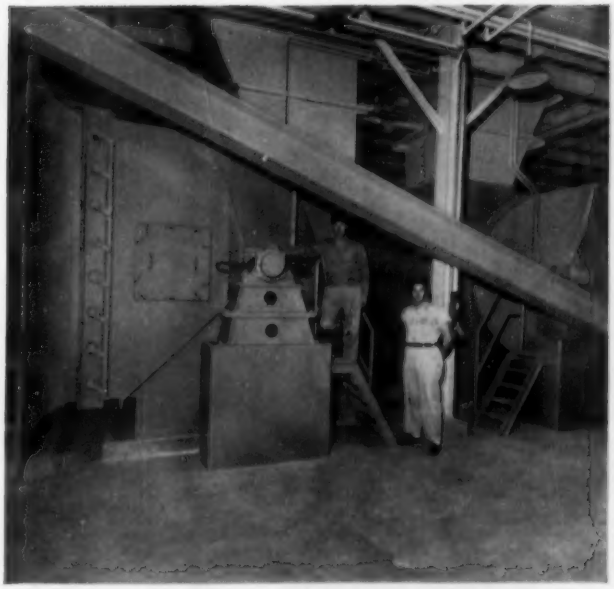
DP&L's No. 1 unit at Parkdale Plant has 87,000 kw generating capacity. The No. 2 unit, now under construction (far right) will add an additional 115,000 kw of capacity.



DP&L expansion program will increase capacity 48 per cent in two years

Two 115,000 kilowatt generating units under construction at Dallas Power & Light Company plants would have served all of metropolitan Dallas' electrical needs as late as 1949. One of the two new units is shown at left at Parkdale Plant, and the other is being built at DP&L's Mountain Creek Plant. Together, the new generators will increase the company's capability 48 per cent by the end of 1956. They will help meet peak demands on DP&L's system which have risen at an average rate of 17 per cent each year since 1946.

chooses Plant



Two American Blower Forced Draft Fans are in operation at the Parkdale Plant. Capacity of each is 123,500 cfm at 100° F at 29" sp. Each fan is driven by an 800-hp motor.

PARKDALE PLANT, newest of Dallas Power & Light Company's generating stations, is the Company's first station to use a pressure furnace. For its initial unit and for Unit No. 2, which is scheduled for completion early in 1955, Dallas Power & Light Company selected American Blower Sirocco Forced Draft Fans.

American Blower Sirocco Fans have long been favorites with progressive power plant operators throughout the United States and Canada. And for good reasons! Sirocco Fans are extremely quiet in operation; they are dependable; and they are economical to run.

In addition to Mechanical Draft Fans for both forced and induced draft, American Blower manufactures Fly Ash Precipitators, Heavy-duty Steam Coils and Gyrol Fluid Drives, for smooth adjustable speed control of fans and boiler feed pumps.

If you have an air handling problem, or plan to expand or modernize your facilities, let American Blower's wide experience work for you. Contact your nearest American Blower Branch Office or write us direct.

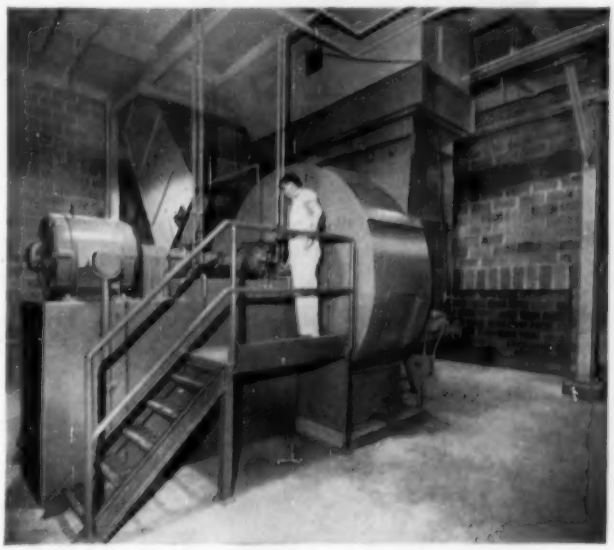


Photo shows an American Blower Recirculating Gas Fan in operation at the Parkdale Plant. Driven by a 100-hp motor, it is rated at 54,000 cfm at 775° F at 6.6" sp.

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN • CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO

Division of American Radiator & Standard Sanitary Corporation

AMERICAN BLOWER

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NEW UTILITY STATIONS C-E EQUIPPED

Includes stations placed in operation since the war (in white) and those under construction or being engineered.

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CECIL LYNCH • HAVANA
MEREDOSIA • PERMIAN BASIN
O. H. HUTCHINGS • REX BROWN
HICKLING • B. C. COBB
RUSSELL • SEWAREN
POSSUM POINT • CUTLER
PORT JEFFERSON • WHITE RIVER
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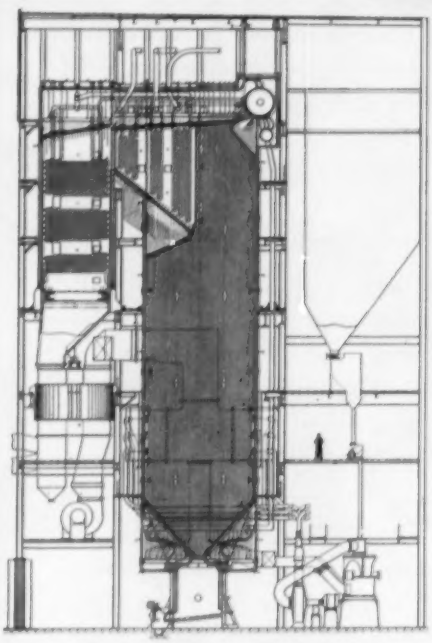
W. SPRINGFIELD • WOOD RIVER
DAN RIVER • LAKE CATHERINE
HARRY NEWMAN • JIM HILL
HUTCHISON • YATES
DUNKIRK • TITUS • LEE
CONTRA COSTA • HAWTHORN
NINEMILE POINT • EDGE MOOR
PALATKA • JOHNSONVILLE
DANSKAMMER • BECKJORD
HIGHGROVE • PLANT X
BLACK DOG • ALBANY
JOPPA • MERAMEC
PORTSMOUTH • LAKE CREEK
ETIWANDA • AURORA
HENNEPIN • EASTLAKE
OAK CREEK • SUWANNEE RIVER
URQUHART • KINGSTON
SANDOW • MULLERGREN
BARRY

NORTH OMAHA

SAGUARO
WILMINGTON
MILLIKEN
JOHN SEVIER
VERMILION
GALLATIN
BARRETT
CARBON



Shown above is a cross-sectional view of the C-E Unit now in service at the North Omaha Station. It is a radiant-reheat boiler with a reheater section located between the primary and secondary superheater surfaces. Economizer surface is located below the rear superheater sections and regenerative air heaters follow the economizer surface. Pulverized coal firing is used employing bowl mills and tilting, tangential burners.

C-E

COMBUSTION

BOILERS, FUEL BURNING & RELATED EQUIPMENT; PULVERIZERS,

NEW NORTH OMAHA STATION

goes into service

The first modern, reheat-cycle power plant in Nebraska was placed in service on July 1st of this year when the new North Omaha Station of the Omaha Public Power District went "on the line."

Located on the Missouri River, in the vicinity of 24th and Craig Avenue in North Omaha, this latest addition to the Power District's electrical generating facilities increases the District's over-all capacity by 35% and will contribute about 45% of the annual kilowatt-hour requirements.

Initial work on the 103-acre site was begun early in 1952 and although progress was quite seriously delayed by unusual circumstances – such as the flood of the Missouri River – the first section of this fine new station is now in full operation.

Unit No. 1 – of what is ultimately planned as a six-unit station – is of 75,000 kw capacity designed for a throttle pressure of 1450 psi with a steam temperature of 1000 F, reheated to 1000 F.

The turbine-generator is served by a C-E Reheat Steam Generator, a cross-sectional elevation and brief description of which are shown on the opposite page. 8-788

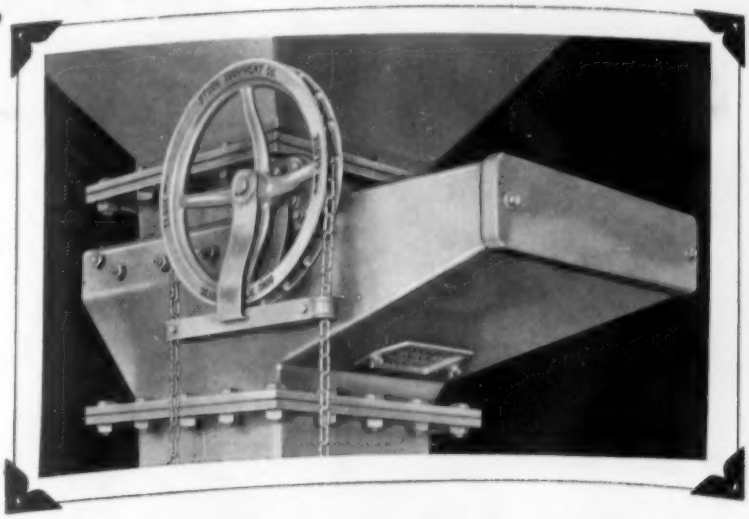
ENGINEERING Combustion Engineering Building
200 Madison Avenue, New York 16, N. Y.

AIR SEPARATORS & FLASH DRYING SYSTEMS; PRESSURE VESSELS; AUTOMATIC WATER HEATERS; SOIL PIPE

It's BRAND SPANKING NEW!

BABY'S NAME *The New S-E-Co. Coal Valve*

BABY'S PHOTO

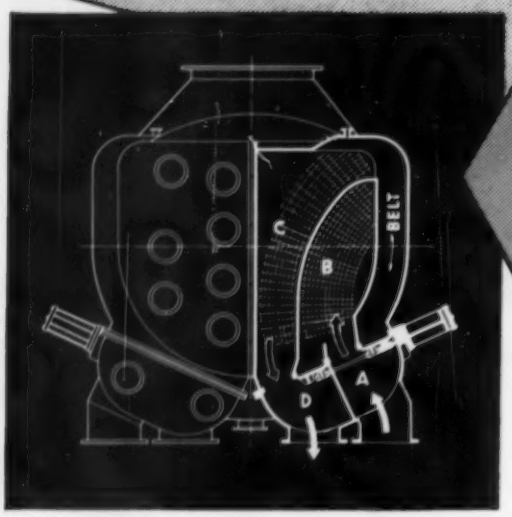


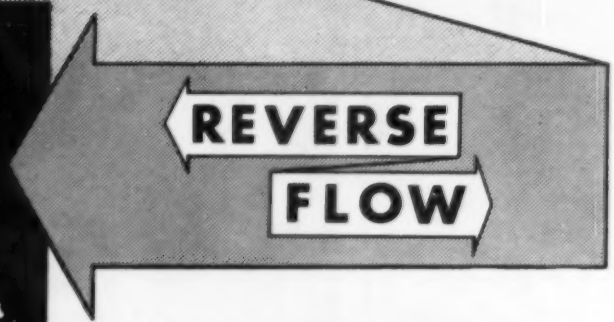
BABY'S WEIGHT *Very substantial — long life expectancy*

FEATURES *Deep U section gate — self-cleaning racks and pinions — lap seal four sides of gate — same super quality inherent in entire S-E-Co. line.*

PROUD PARENTS *The Stock Equipment Company*
745 Hanna Bldg., Cleveland 15, Ohio.

C. H. WHEELER "SELF CLEANING" PATENTED REVERSE FLOW STEAM CONDENSER





Illustrated is the C. H. Wheeler tandem arrangement in which both sluice gates operate on a single stem. In this divided water box condenser, water enters chamber A with left hand port open and flows in through pass B, out through pass C and through left hand port D. To reverse the flow, gates move to left, closing the left hand ports and opening the right hand ports of chambers A & D. Water now flows through bolt, in through C and out through B and right hand port of D. The same method applies, of course, to a non-divided water box design.

No Shutdown — No Vacuum Loss for Tube Cleaning

The C. H. Wheeler Patented Reverse Flow design makes either single or divided water box steam condensers self-cleaning. These condensers are saving power plants countless hours of downtime and reduced load formerly required for manual removal of debris and organic growth from clogged tube sheets.

"Self-Cleaning" is accomplished by a set of sluice gates built integrally into C. H. Wheeler Surface Condensers which may be electrically or hydraulically operated to reverse the flow of cooling water through the tubes. This sudden flushing-in-reverse removes all debris and crustaceous matter and carries it out the discharge while carrying full load on the turbine and without reducing water flow. Also, the quick change in temperature shocks and dislodges marine growth.

Depending on condition of the cooling water, C. H. Wheeler Reverse Flow condensers have gone two years and longer before requiring cleaning. A typical field report tells of regaining a half-inch loss of vacuum (due to fouled tubes and tube sheets) five minutes after reversing the flow of condenser cooling water.

C. H. Wheeler custom - designs Reverse - Flow Condensers to suit any installation, arranging sluice gates and nozzles at top or bottom of water box and at any angle desired. Call a C. H. Wheeler representative to go over your specifications. It will mean years of substantial savings.

(BULLETIN 410 mailed on request)

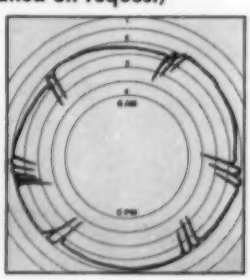
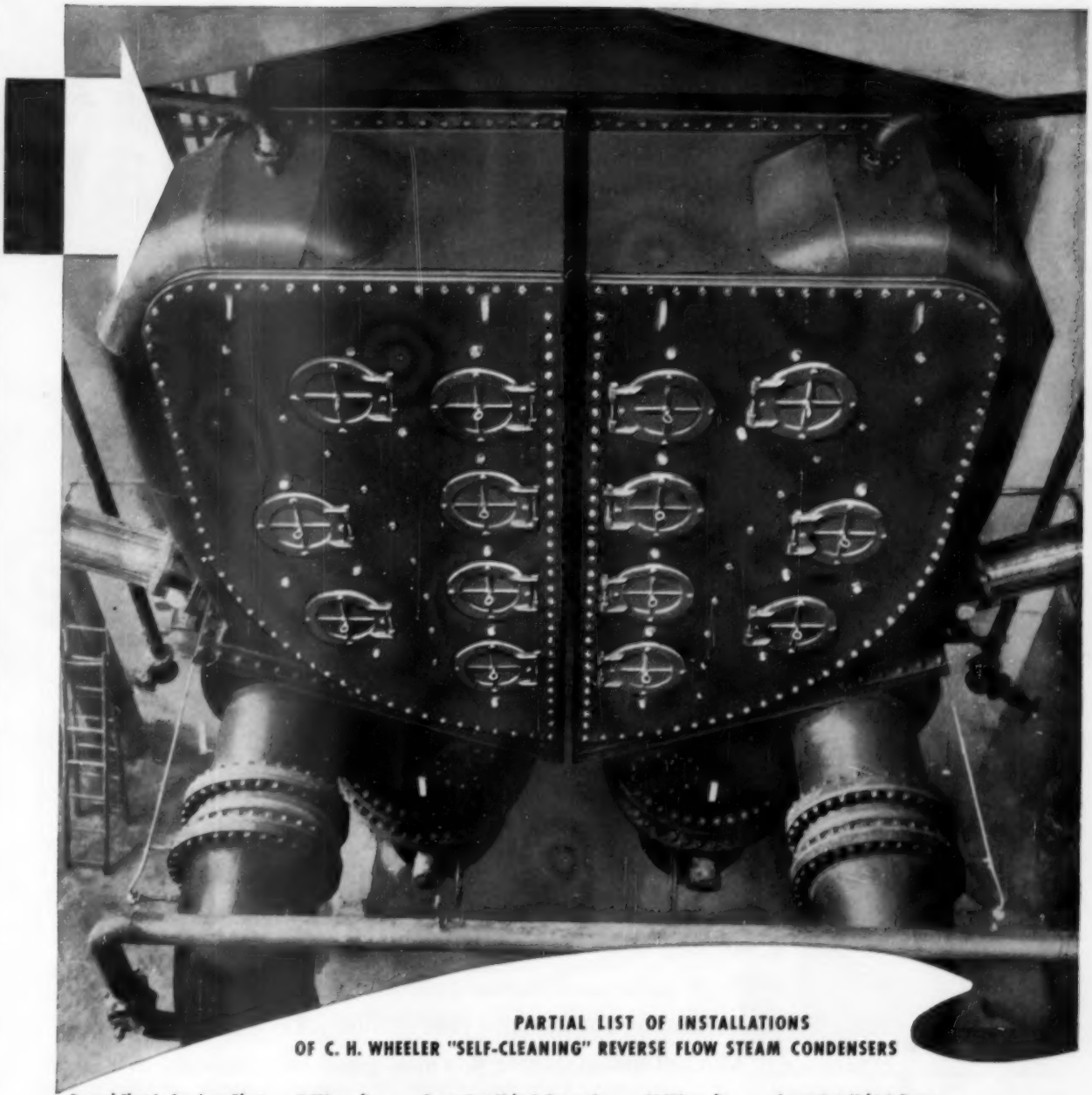


Chart shows typical cycle of vacuum and effect of reverse flow in a C. H. Wheeler Patented Self-Cleaning Reverse Flow Condenser. Note that because of 100% back flushing, the loss of vacuum during the reverse flow cycle is negligible.

SEE IT AT THE POWER SHOW — PHILADELPHIA, DECEMBER 2, 3, 4, 6, 7



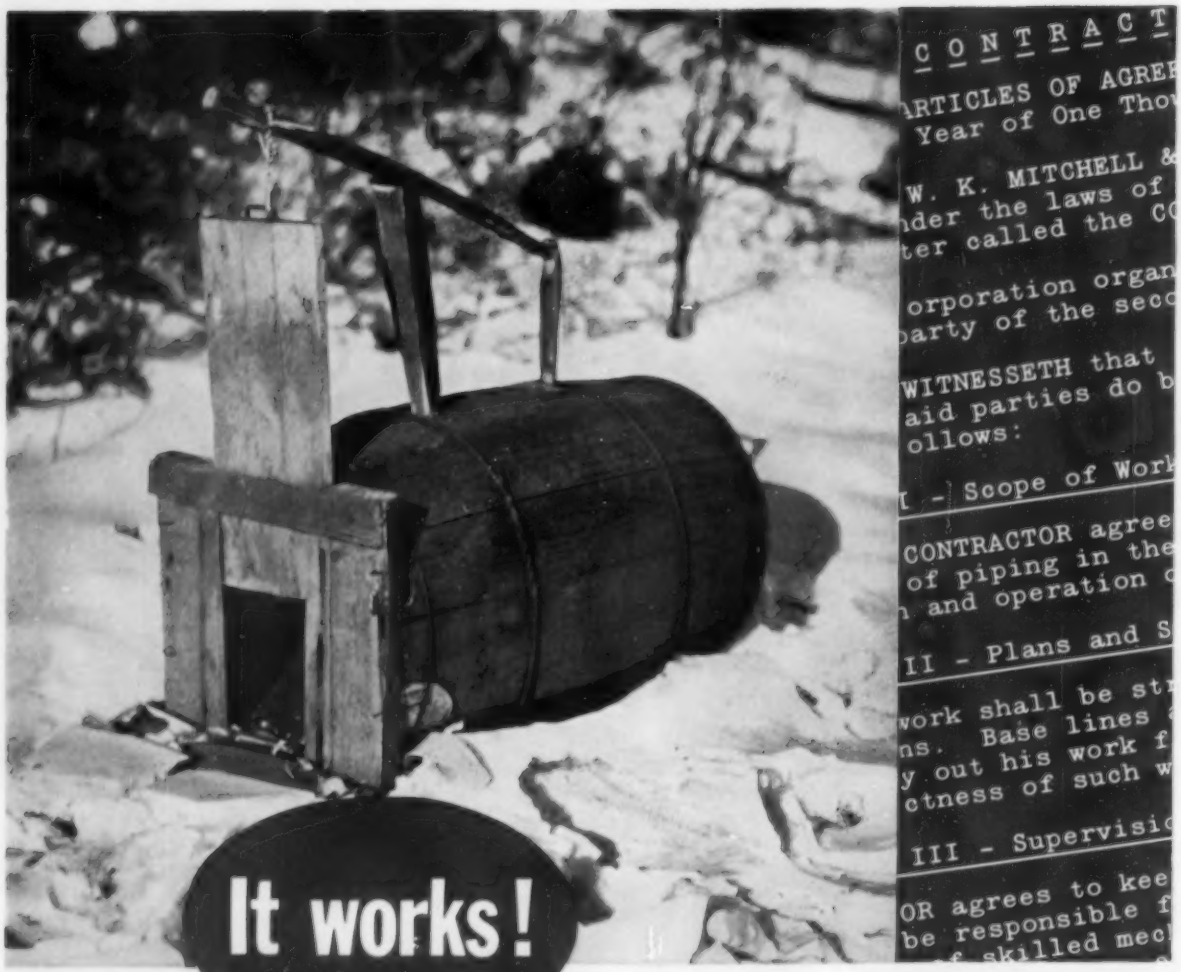
PARTIAL LIST OF INSTALLATIONS
OF C. H. WHEELER "SELF-CLEANING" REVERSE FLOW STEAM CONDENSERS

General Electric Co., Lynn Plant . . 8,900 sq. ft.
General Electric Co., Lynn Plant . . 12,500 sq. ft.
Keystone Steel & Wire, Peoria . . 10,000 sq. ft.
Virginian Railways, W. Va. . . . . 15,000 sq. ft.
City of Wyandotte, Mich. . . . . 12,000 sq. ft.
City of Kansas City, Kansas. . . . 32,500 sq. ft.
New Bedford Gas & Edison Light,
New Bedford, Mass. . . . 16,500 sq. ft.
New Bedford Gas & Edison Light . 25,000 sq. ft.
Connecticut Light & Power Co.,
Montville Station . . . . . 24,000 sq. ft.
Connecticut Light & Power Co. . . 24,000 sq. ft.
Connecticut Light & Power Co.
Devon Station . . . . . 50,000 sq. ft.
Georgia Power Co., Atkinson Station, 47,000 sq. ft.
Alabama Power Co , Units 1 & 2
Gadsden Station . . . . . 47,000 sq. ft.
City of Holland, Michigan . . . . . 13,000 sq. ft.
South Carolina Electric & Gas,
Unit #1 Urquhart Station . 45,000 sq. ft.
South Carolina Electric & Gas,
Unit #2 Urquhart Station . 45,000 sq. ft.
Connecticut Light & Power,
Montville Station . . . . . 55,000 sq. ft.
Monongahela Power Company,
Albright #3 . . . . . 65,000 sq. ft.
Georgia Power Company,
Hammond Station. Units 1-2-3, 74,000 sq. ft.
City of Jacksonville, Fla.,
Southside Station . . . . . 40,000 sq. ft.
Tallyrand Station . . . . . 40,000 sq. ft.

C. H. WHEELER *of Philadelphia*

C. H. WHEELER MANUFACTURING CO., 19th & LEHIGH, PHILADELPHIA 32, PENNA.

Steam Condensers • Centrifugal, Axial and Mixed Flow Pumps • Steam Jet Ejectors • Vacuum Refrigeration
High Vacuum Process Equipment • Micro-Particle Reduction Mills • Marine Condensers and Ejectors • Deck Machinery



A hatchet, a saw and basic principles are all a farmer boy needs for end results. Solving the complex piping problems of power and process industries calls for higher degrees of craftsmanship, but the same rigid economy. Let the vast experience of Mitchell specialists save you money *and headaches* on your next installation of high-temperature or high-pressure piping.

W. K. MITCHELL & CO., INC.
2946 Ellsworth Street, PHILADELPHIA 46, PA.

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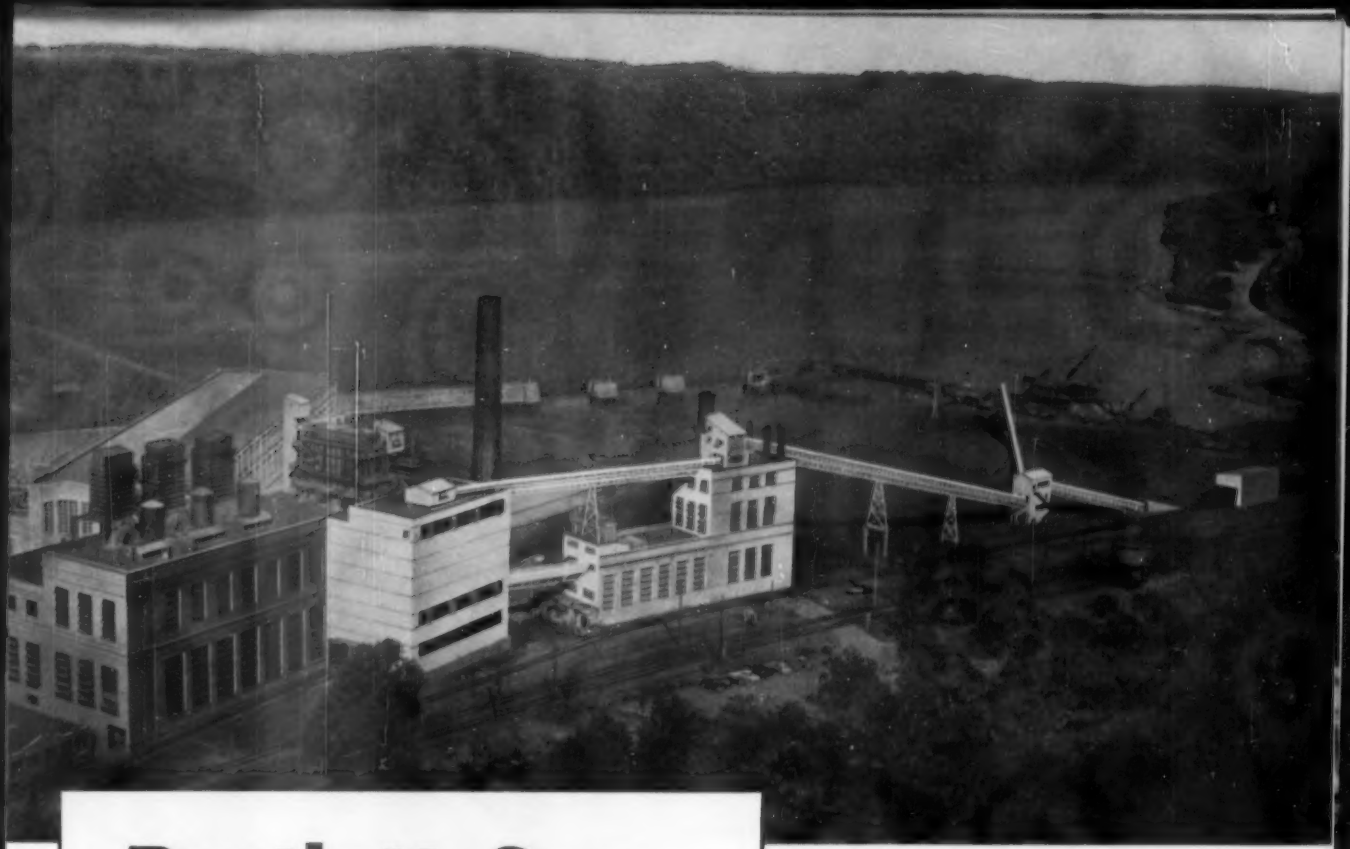
(PATENTED)

MITCHELL PIPING
SINCE 1899

PIPING FABRICATORS AND CONTRACTORS



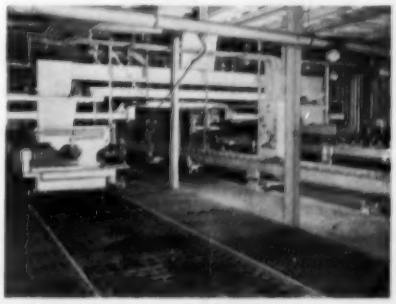
General View of Holtwood Steam Station
Pennsylvania Water and Power Co.
Ebasco Services Incorporated
Consulting Engineers.

Bartlett-Snow coal handling at Holtwood

● Coal handling facilities in this plant, that burns anthracite coal dredged from the river and reclaimed by the floatation process, were engineered by Bartlett-Snow to Ebasco specifications, fabricated in our shops, and installed by our erectors. The equipment includes combination receiving and reclaim hopper fitted with vibrating feeders, a 360 ton per hour conveyor system, 36″ cantilever storage conveyor; and two 42″ shuttle conveyors for wet coal and a 14″ screw conveyor for dry coal in the distributing room over the bunkers.

For fixed responsibility that insures highly efficient, synchronized operation of all parts of the system as a unit, and low maintenance and low operating costs — let the Bartlett-Snow coal handling engineers work with you on your next new plant, modernization or plant expansion program!

View of 36″ Cantilever Storage Conveyor Anchored Permanently on a Hollow Concrete Silo that Withstands Avalanching of Coal.



View of Two 42″ Wide Shuttle Conveyors for Wet Coal and 14″ Diameter Screw Conveyor for Dry Coal in Distributing Room Over the Bunkers.

DESIGNERS
ENGINEERS

BARTLETT-SNOW
CLEVELAND 5, OHIO

FABRICATORS
ERECTORS

"Builders of Equipment for People You Know"

Could You Use SAVINGS *Like These?*

40% less
Fuel Consumption
50% more
Boiler Capacity

Bailey Meters and Controls Insure Savings at Kerr Bleaching & Finishing Works, Concord, N. C.

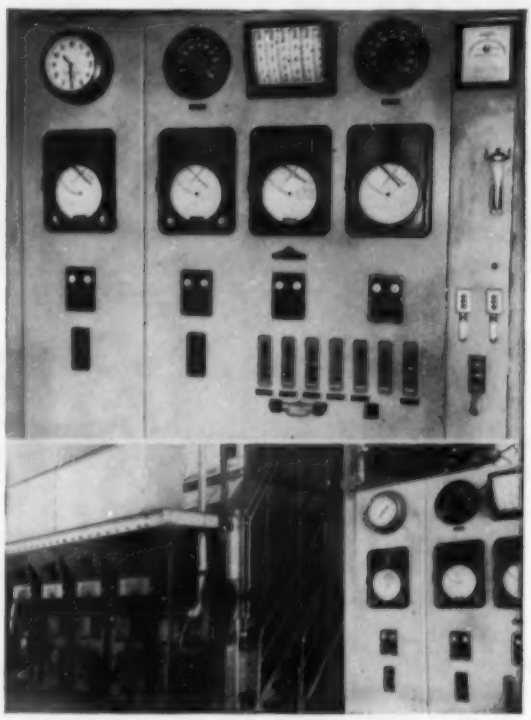
The key to complete returns on any investment in new power equipment is a fully co-ordinated system of meters and controls. It's the old story, the tail that wags the dog—careful attention to this comparatively minor part of the over-all installation cost can mean the difference between profit and loss in operation.

Here's where Kerr Bleaching & Finishing Works has cut operating costs—by installing *co-ordinated* Bailey Meters and Controls. The installation includes Bailey Meter Combustion Control, and Bailey Two-element Feed Water Control.

Such a co-ordinated system is an important plus for Bailey customers. Nowhere else can you buy such a complete range of equipment, selected without bias to do the best job for you. Nowhere else can you find such expert engineering service, immediately available through conveniently located direct sales and service representation. May we help you?

Call our local branch office or write for Bulletin 15-H.

A-113



Control panel, showing completely co-ordinated Bailey Meters and Controls at Kerr Bleaching and Finishing Works, Concord, N. C.

BAILEY METER COMPANY

BAILEY METERS

1025 IVANHOE ROAD
CLEVELAND 10, OHIO

Controls for Steam Plants
COMBUSTION · FEED WATER
TEMPERATURE · PRESSURE
LIQUID LEVEL · FEED PUMPS

Our friendships are one of the blessings for which we are thankful

EASTERN GAS AND FUEL ASSOCIATES

BEACON COAL

EASTERN GAS AND FUEL ASSOCIATES

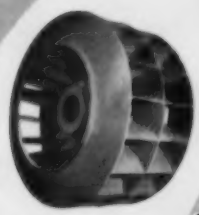
PITTSBURGH BOSTON CLEVELAND DETROIT NEW YORK NORFOLK PHILADELPHIA SYRACUSE

For New England: New England Coal & Coke Co. For Eastern Gas and Fuel Associates, Inc.

NOT A WEAK LINK

IN THE CONSTRUCTION OF "BUFFALO" INDUCED DRAFT FANS

rotor



housing

bearings

shaft

So much depends on the continued operation of your draft fans that it pays to be sure that there are no weak links in the construction. Housings, wheels, blades, bearings and shafts — *all* must be up to the job, or the fan as a whole cannot function.

Every part of a "Buffalo" Induced Draft Fan is built up to stand known conditions of wear, heat and erosion. The shaft is turned from a solid piece of forged steel with extra large thrust collars. Bearings are heavy-duty, self-aligning and water-cooled. Housings are heavy-gauge steel, hot-riveted, with removable scroll liners where erosion is most severe. Blades are built up with welded-on wearing strips. In short, every "link" in the construction of these fans is designed for maximum long life in this punishing fan job.

It is all part of the "Q" Factor* which assures you of best results whenever you buy "Buffalo". Write now for Engineering Bulletin 3750.

BUFFALO FORGE COMPANY

170 MORTIMER STREET BUFFALO, N.Y.

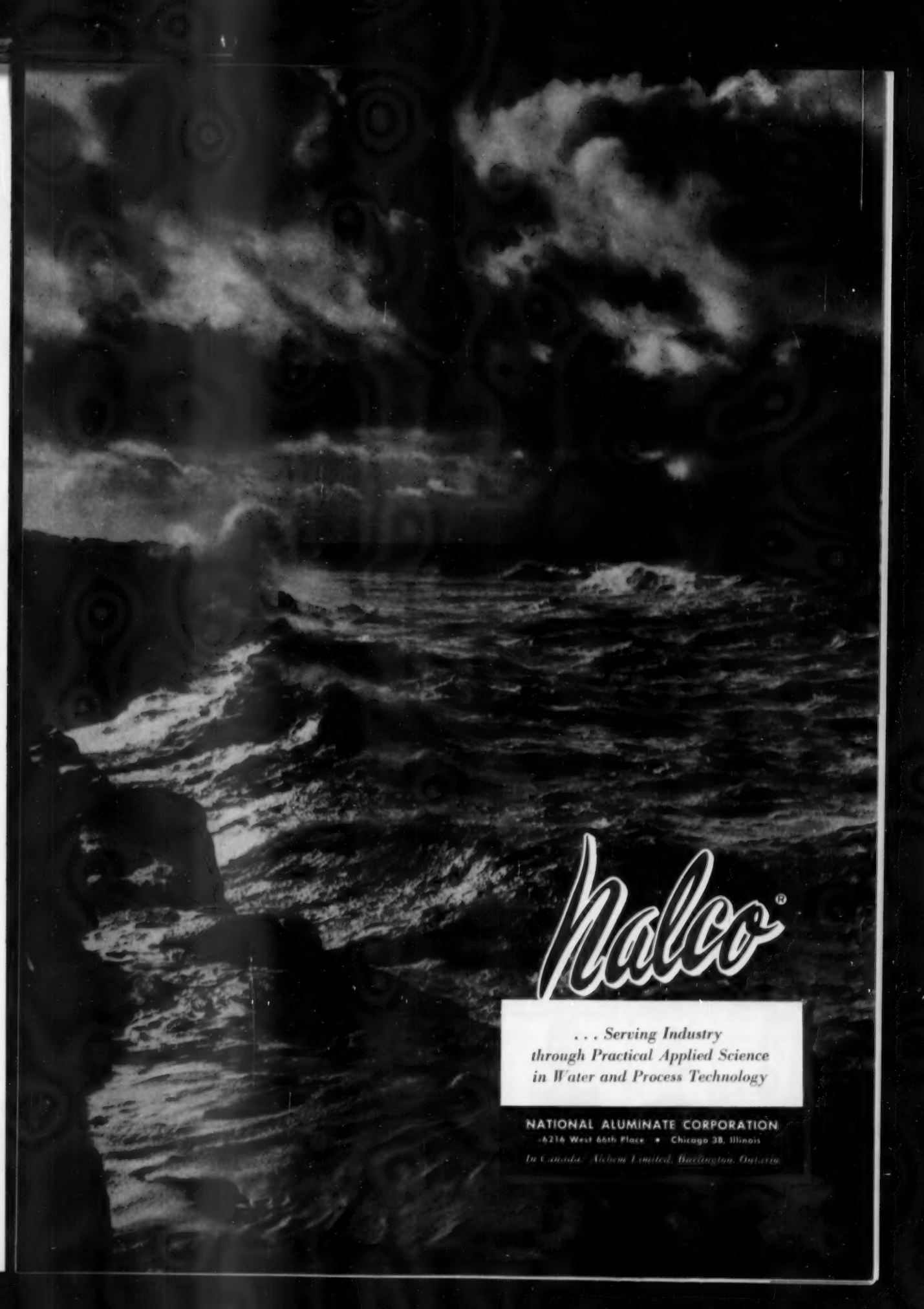
PUBLISHERS OF "FAN ENGINEERING" HANDBOOK

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

Sales Representatives in all Principal Cities

"Buffalo" DRAFT FANS

** The "Q" Factor — The built-in quality which provides trouble-free satisfaction and long life.*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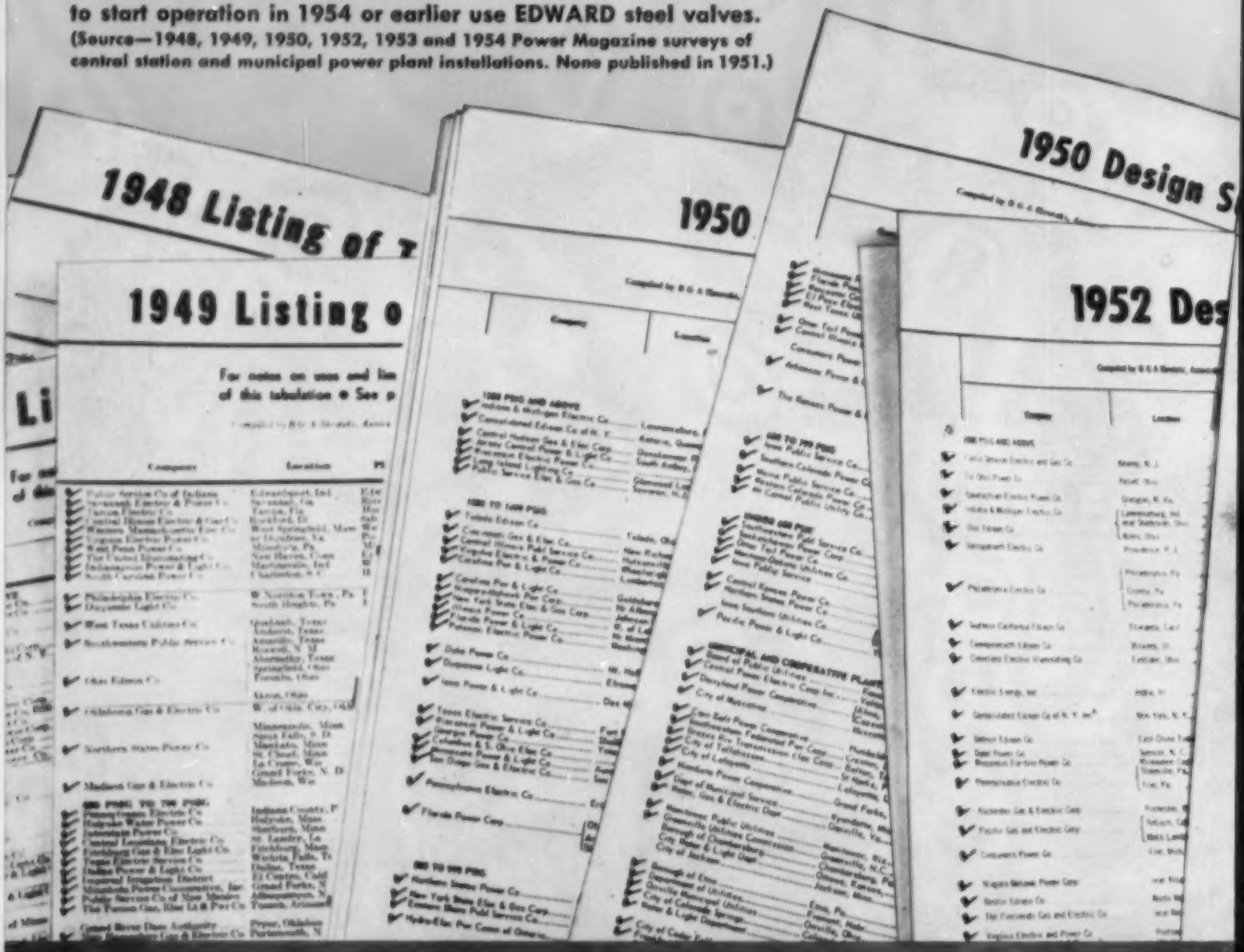
through Practical Applied Science
in Water and Process Technology
NATIONAL ALUMINATE CORPORATION
6216 West 66th Place • Chicago 38, Illinois
In Canada: Nalcom Limited, Burlington, Ontario

Again in '54 it's Edward Valves

THE EVIDENCE: **674 out of 699 (96.42%) of new central station and municipal power plant projects scheduled to start operation in 1954 or earlier use EDWARD steel valves.**

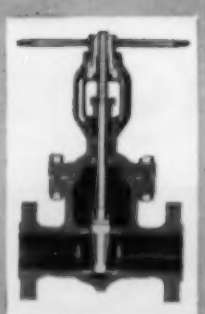
(Source—1948, 1949, 1950, 1952, 1953 and 1954 Power Magazine surveys of central station and municipal power plant installations. None published in 1951.)



TYPICAL EDWARD DESIGNS GOING INTO NEW STATIONS

Cast Steel Non-Return

Cast Steel Stop

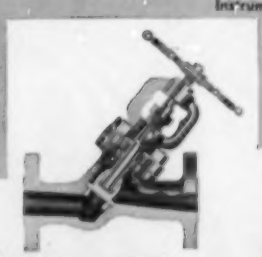


Cast Steel Gate

Cast Steel Check

Forged Gage

Forged Stop



Blow-off

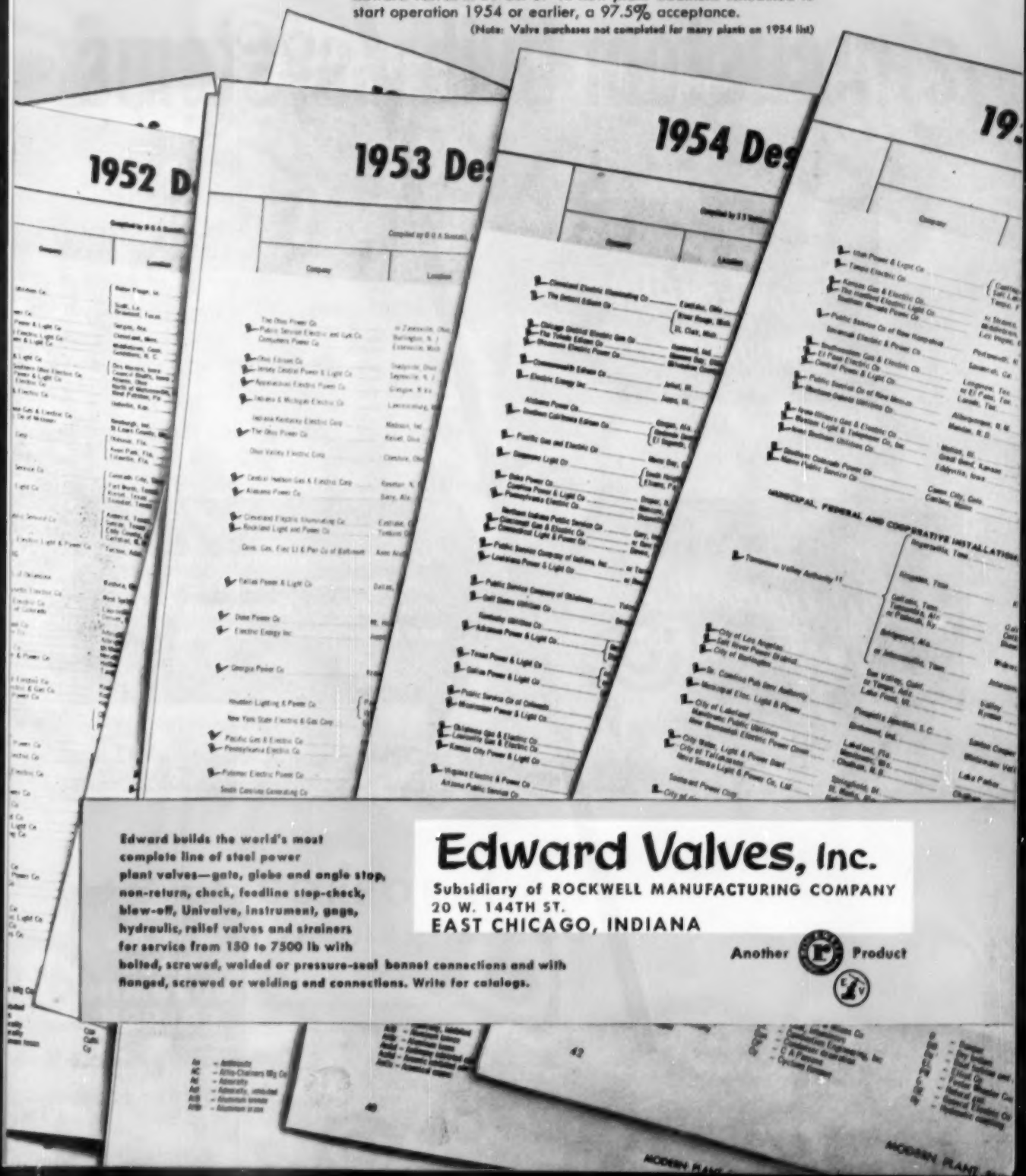
Forged Instrument

Forged Univalves

in over 96% of new power plants

✔ Indicates identified purchases of Edward valves for specific generating capacity additions. In the 1954 survey, records show Edward valves in 39 out of 40 new plant additions scheduled to start operation 1954 or earlier, a 97.5% acceptance.

(Note: Valve purchases not completed for many plants on 1954 list)



Edward builds the world's most complete line of steel power plant valves—gate, globe and angle stop, non-return, check, feedline stop-check, blow-off, Univalve, instrument, gage, hydraulic, relief valves and strainers for service from 150 to 7500 lb with bolted, screwed, welded or pressure-seal bonnet connections and with flanged, screwed or welding end connections. Write for catalogs.

Edward Valves, Inc.

Subsidiary of ROCKWELL MANUFACTURING COMPANY
20 W. 144TH ST.
EAST CHICAGO, INDIANA

Another Product

custom built systems

HAGAN
automatic combustion controls

HAGAN
ring balance instruments

For thirty-five years the leaders in advancing steam production efficiency with Automatic Combustion Control and Instrumentation Systems.

HAGAN
HALL
BUROMIN
CALGON

from standard components

Custom Built from standard components sounds like a contradiction. But it is a fact that each Hagan unit is designed, not only to perform its specific functions efficiently, but also to operate smoothly in combination with other Hagan components. Thus, every Hagan System of Automatic Combustion Control and Instrumentation can be custom built to maintain the exact operating conditions which result in optimum steam production efficiency.

Thirty-five years of experience with all types of boilers, and with every combination of temperature, pressure and fuel system requirements, goes into the design of every Hagan unit and system. As a result, a Hagan System is thoroughly coordinated and easy to calibrate. Adjustments are ample in number and range, so that our engineers—or yours—can get the entire system into accurate operation with a minimum loss of time.

Many of our customers have standardized on Hagan Controls and Instruments for improving existing facilities and for extensions and new construction.

Make Hagan Automatic Combustion Control and Instrumentation the choice for your next installation!

HAGAN CORPORATION

HAGAN BUILDING • PITTSBURGH 30, PENNSYLVANIA

Boiler Combustion Control Systems • Ring Balance Flow and Pressure Instruments • Metallurgical Furnace Control Systems • Control Systems for Automotive and Aeronautical Testing Facilities

"Build us a Long Retract . . .

this was the **problem**

Designers have talked of boilers 60 or more feet wide, but it had seemed impossible to clean them. Now this problem has been solved by the Vulcan long retract shown at the right. With two entering the furnace from opposite sides, boilers larger than have ever been built can be cleaned dependably.

THIS Vulcan long retractable soot blower has been thoroughly tested. It has dual electric-motor drive. It has the double-helix cleaning pattern that has made Vulcan the standard for effective cleaning of furnaces up to 50 feet wide. Yet, for all its length, it is compact. It is easy to install, operate and maintain. With this new T-30, Vulcan is ready to clean your most modern boilers, no matter how large or how small they might be.

COPES-VULCAN DIVISION
CONTINENTAL FOUNDRY & MACHINE COMPANY
ERIE 4, PENNSYLVANIA

VULCAN *Automatic*

and we do mean Long"

VULCAN
KNOW-HOW
COSTS MORE
—But is Worth it

Soot BLOWERS

Prevent heat loss up the stack. Too much or too little excess air means big money in today's boiler plant. It's important to *know* and *control* excess air exactly—regardless of load or fuel changes.

Burn multiple fuels efficiently

When switching from one fuel to another or burning more than one fuel at the same time, only an Oxygen Recorder gives you an undistorted picture of excess air. It measures O_2 directly and continuously, without recalibration.

Hundreds of companies are reaping large savings with Hays Electronic type Oxygen Recorders in their boiler plants. Flue gas sampling systems fit a wide variety of installations.

With the Hays Electronic type Oxygen Recorder you get continuous, highly accurate indication and recording . . . complete compensation for temperature and pressure effects . . . freedom from chemicals or hazardous fuel burning in the analyzing process . . . swift, sure electronic operation.

Write today for Hays Bulletin 52-829-56. Also ask for a dramatic comparison graph which shows that the relationship between O_2 and excess air is practically constant for different fuels.

Automatic Combustion Control
Boiler Panels • CO_2 Recorders
Veriflow Meters and Vertrol
Gas Analyzers • Draft Gages
Combustion Test Sets
Electronic Oxygen Recorders
Electronic Flowmeters
Electronic Feed Water Controls
Miniature Remote Indicators

THE hays CORPORATION

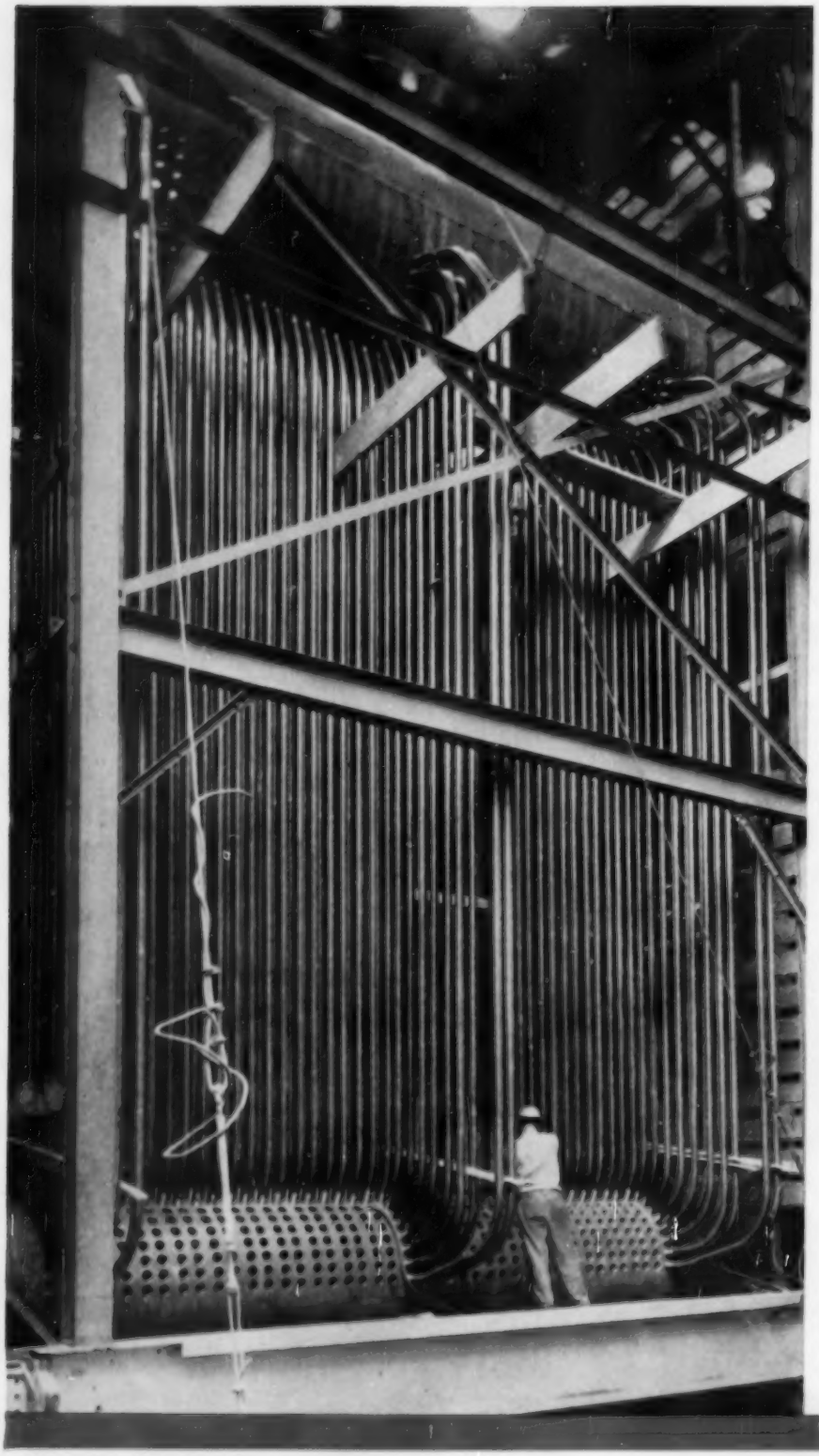
MICHIGAN CITY 1, INDIANA

Wherever heat,

light or power

is needed

Old Ben Coal Corporation / Chicago 4, Illinois



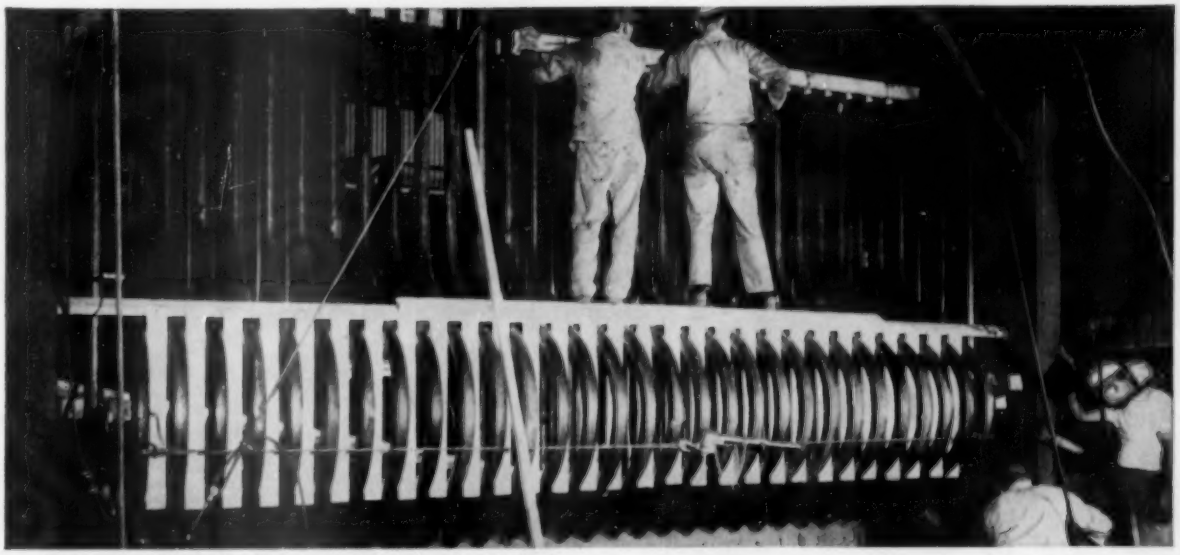
How to make sure

you get

"Intestinal Fortitude"—16 mm. sound, black and white film, 17 minutes. The story of ELECTRUNITE Pressure Tubes from ore to finished product. To arrange for a free showing, write to Republic Steel and Tubes Division.

Every ELECTRUNITE Boiler Tube has identical metallurgical and physical properties. Because wall thickness is uniform, there are no longitudinal thin spots. Heat transfer is uniform.

See our exhibit at the 21st National Exposition of Power and Mechanical Engineering, Commercial Museum, Philadelphia, Pa., December 2-3-4-6-7. BOOTH NO. 113.



Because ELECTRUNITE Boiler Tubes are uniformly ductile, springback can be accurately calculated before the bending operation. Result: smooth, accurate bends; a neat, efficient job with a minimum of adjustment.

the power you've bought

Like Kellogg Co., see that your new power plant is equipped with Republic ELECTRUNITE Boiler Tubes

Dependable, Republic ELECTRUNITE Boiler Tubes are made from high-grade steel, produced in Republic's own mills. Operations are quality controlled from the time the ore is mined, through all manufacturing stages.

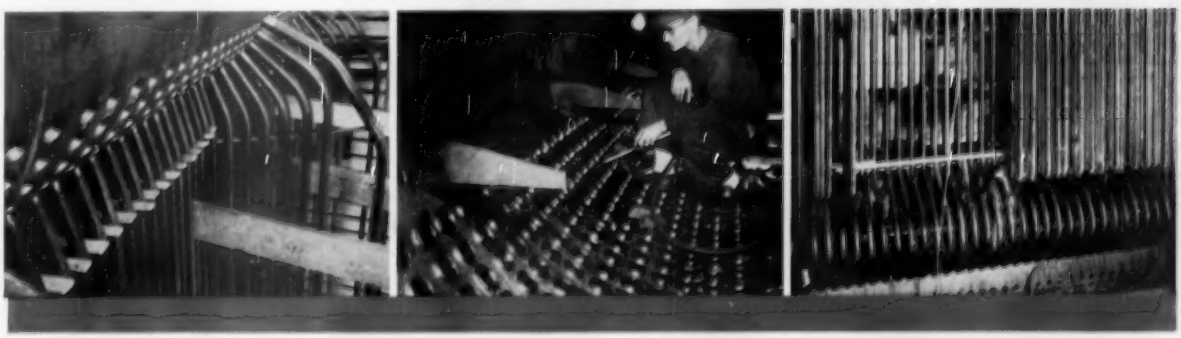
Tubes give uniform heat transfer, all around the tube, from end to end. Why? Because wall thickness is uniform. And because ductility is uniform, too, smooth bending and roller expanding are possible. Installation is easier, often less expensive.

It all adds up to a question of economics. If you take the long view on power plants, you'll want to consider Republic ELECTRUNITE Boiler Tubes. More and more consulting engineers are specifying them. Not only for old plants being modernized, but for new ones as well.

Before you decide on your specifications, get all the facts about Republic ELECTRUNITE Process and Pressure Tubes. Write for: BT-10.

REPUBLIC STEEL CORPORATION
Steel and Tubes Division
209 East 131st Street, Cleveland 8, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York, 17, N. Y.

Republic ELECTRUNITE
BOILER, CONDENSER AND HEAT EXCHANGER TUBES



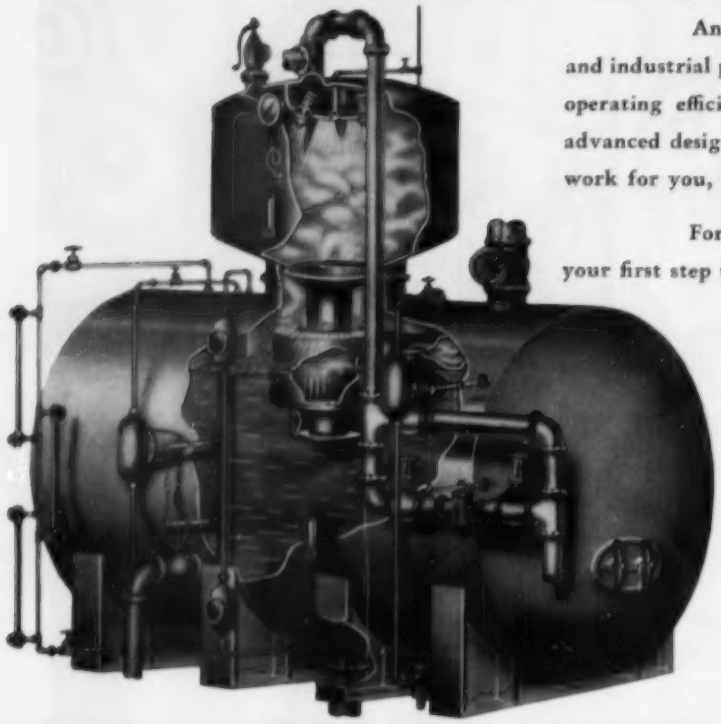
Boiler erectors like the way ELECTRUNITE Boiler Tubes slide easily into headers. The reason: uniform diameter, uniform ductility. Republic's quality control of ELECTRUNITE Boiler Tubes from ore to finished product makes this uniformity possible.

Because they are normalized in a controlled atmosphere, Republic ELECTRUNITE Boiler Tubes have scale-free surfaces. Grinding tube ends, which destroys uniformity, is not necessary. Tubes slide into drum holes easily, expand uniformly.

Part of the new 100,000 lbs./hr.—750 PSI—750 F. Steam Generating Unit installation at Kellogg Co., Battle Creek, Michigan. Designed, built and installed by Riley Stoker Corp., Worcester, Mass. Sargent & Lundy, Consulting Engineers, Chicago, Ill.

In Deaeration, too

BELCO Builds a Complete Line-

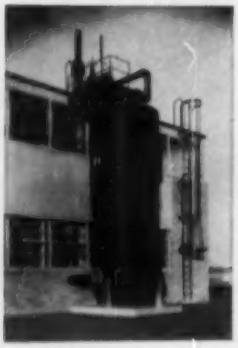


An increasing number of well known utility and industrial plants are using Belco equipment to increase operating efficiency and decrease operating costs. Belco advanced design and application experience can be put to work for you, too.

For technical assistance write or call Belco — your first step to lower costs.

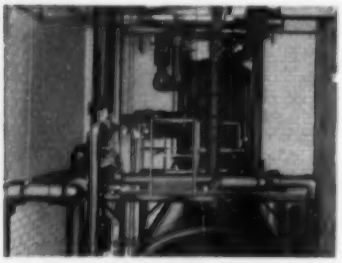
SPRAY TYPE — Belco Deaerator in large eastern oil refinery. Has a capacity of 300,000 lbs/hr.

MARINE TYPE—Typical Belco marine heater furnished to shipyards. (Approved by Lloyds of London)

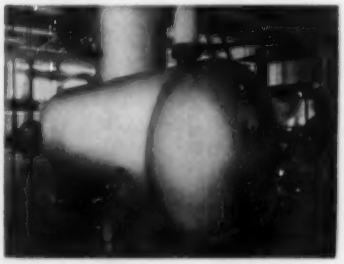


OPEN TYPE—Deaerator at large eastern pharmaceutical plant. Capacity of 80,000 lbs/hr.

VACUUM TYPE — Unit shipped set-up to midwestern utility. Has 150,000 lbs/hr capacity.



SPRAY TRAY TYPE — Belco Deaerator at New York State institution boiler house. Capacity 120,000 lbs/hr.



TRAY TYPE — Belco Deaerator at southern municipality. Has a capacity of 125,000 lbs/hr.

Belco

Boiler Feedwater Heaters • Water Softeners • Filters • Clarators
Demineralizers • Automatic Process Control Panels

BELCO INDUSTRIAL EQUIPMENT DIVISION, INC.
112 PENNSYLVANIA AVENUE, PATERSON 3, N. J.
REGIONAL OFFICES: *Philadelphia, Pa., Chicago, Ill., Houston, Texas*
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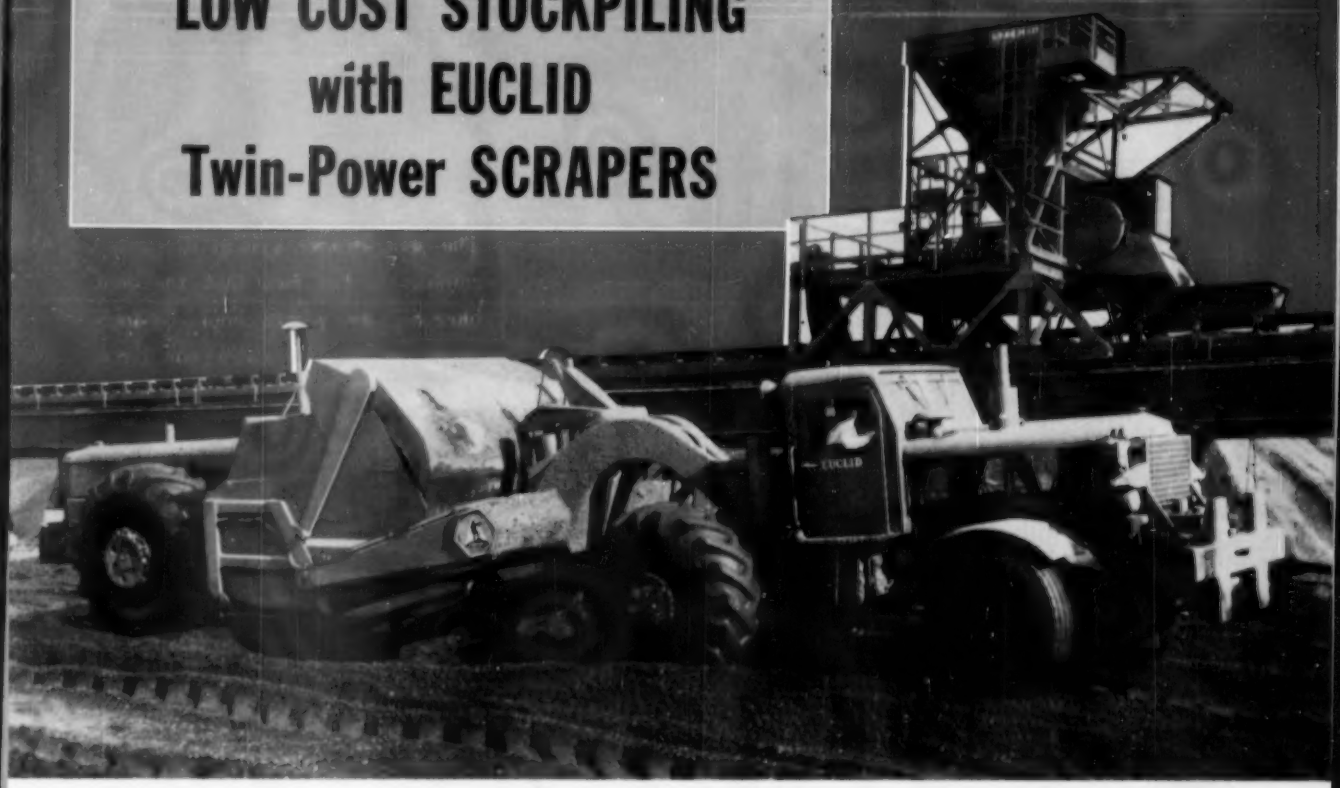
BELCO DESIGNS, ENGINEERS & FABRICATES WATER PROCESSING EQUIPMENT

BETTER COMPACTION... LOW COST STOCKPILING with EUCLID Twin-Power SCRAPERS



- Euclid Twin-Power Scrapers are doing a complete coal handling job for public utilities and industrial concerns . . . and they are doing a better, more efficient job than methods previously used.

Owners report that compaction of the stockpile is increased 10 to 15 lbs. per cubic foot by the heavy rubber-tired scrapers. This practically eliminates spontaneous combustion problems and provides a well drained stockpile.

The "Twin" is completely self-loading in loose, compacted, wet or frozen coal. It can work in very close quarters . . . carries big loads at speeds up to 30 m.p.h. . . . extends, raises or relocates the stockpile. It has proved to be the most economical solution to coal stockpiling and reclamation problems on many operations.

Your nearby Euclid distributor will prepare a production and cost estimate without obligation . . . have him show you how the "Euc" Twin-Power Scraper provides maximum flexibility with minimum investment and operating cost. Write for your copy of a new descriptive folder, Form 551A.

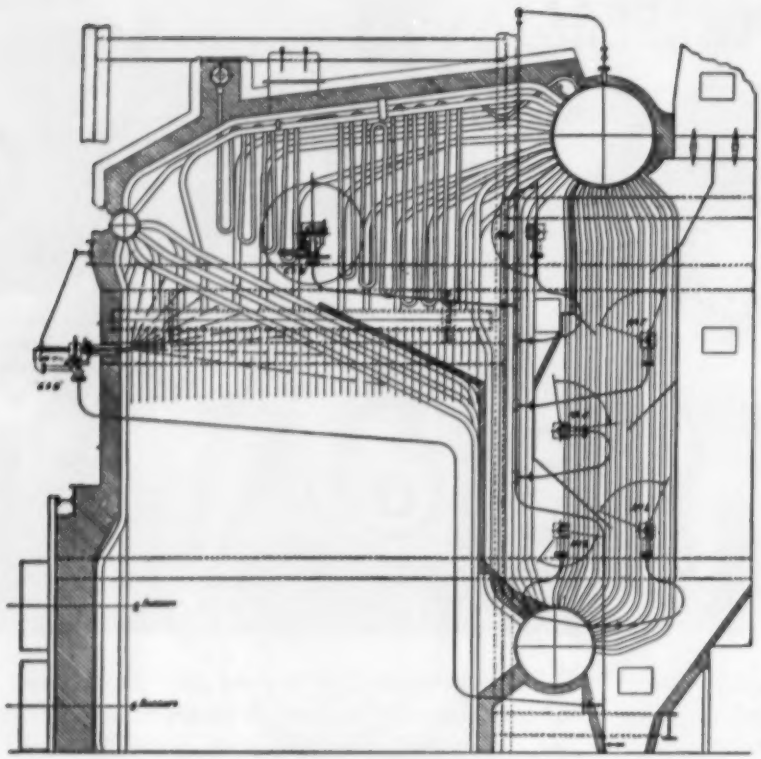
EUCLID DIVISION
GENERAL MOTORS CORPORATION
Cleveland 17, Ohio

Euclid Equipment

FOR MOVING EARTH, ROCK, COAL AND ORE

GM GENERAL MOTORS

CLEAN HEATING SURFACE and LOW MAINTENANCE



460 p.s.i. PULVERIZED COAL FIRED BENT TUBE BOILER

- The high temperature zone, first pass screen tubes are cleaned by BAYER RETRACTABLE GUN TYPE MASS-FLOW CLEANERS located in the front furnace wall. When not in use the nozzle is retracted from the furnace, where it is away from the heat, thus assuring long and efficient service life.

- The superheater is cleaned by BAYER LONG RETRACTABLE MULTI-NOZZLE CLEANERS. The elements are advanced for cleaning and after the cleaning cycle are entirely withdrawn from the furnace. By the use of such Retractable Cleaners heating surface is kept clean at all times, and element maintenance is negligible.

- The rear banks of boiler tubes are cleaned by BAYER conventional revolving elements.

The soot cleaner system illustrated emphasizes the fact that the soot blower in every case should be engineered to suit the operating conditions of the boiler to which it is applied.

BAYER engineering is at your service at any time. We will gladly cooperate with you in order that the best equipment may be correctly applied to efficient cleaning of heating surface under the operating conditions in your plant.

Over the years a large Mid-West Utility Company has used BAYER SOOT BLOWERS. The first installation was made over twenty years ago. Eleven repeat orders for BAYER SOOT BLOWERS to equip new boiler installations have been ordered. The boiler illustrated at the left was installed last year. The record of efficiency, dependability and service demonstrated by BAYER EQUIPMENT in past years resulted in BAYER being selected for the new boiler.

The Bayer Company

ST. LOUIS, MISSOURI, U.S.A.

FOR HIGHEST FIRST AND FINAL VALUE BUY BAYER

Consider the value of Graphitization studies...

...when critical power piping is the order

This is one field where gouging pays off handsomely . . . at least when it's done by the device pictured above, a weld prober which gouges out boat-shaped samples of metal from piping that has seen lengthy service under high-temperature, high-pressure conditions.

When these samples are polished, etched, and then diagnosed under metallographic microscope their evaluation provides basic information in studies of graphitization, the phenomenon which prior to 1943 was considered of only academic interest.

Through the microscope and by means of mechanical tests Kellogg metallurgists carry on a continuous search for evidence of graphitization. They are hunting particularly for what they call the "eyebrow" or chain type of graphite. It is these malformations that cause planes of weakness in carbon steel and carbon moly power piping . . . weaknesses that can result in serious failures.

Although exactly why graphite forms is not definitely known, metallurgists have already come up with positive methods of inhibiting it. Still Kellogg specialists continue their research, endeavoring to pinpoint the exact causes of graphitization and to improve fabricating techniques and materials. More than 6,000 test pieces have been gouged out of actual service piping and evaluated by Kellogg technicians in the past decade.

Continual metallurgical research such as this graphitization program is just one of the basic reasons why any utility company obtains a valuable plus when it specifies . . . *main steam and reheat piping by Kellogg.*

* * *

New Power Piping Booklet Published . . . Send for descriptive literature about Kellogg's extensive facilities for assuring the highest quality workmanship. A section of the booklet is devoted to detailed coverage of the K-Weld* process.

OTHER FABRICATED PRODUCTS include: Pressure Vessels . . . Vacuum Vessels . . . Fractionating Columns . . . Drums and Shells . . . Heat Exchangers . . . Process Piping . . . Bends and Headers . . . Forged and Welded Fittings

FABRICATED PRODUCTS DIVISION

THE M. W. KELLOGG COMPANY

225 Broadway, New York 7, N. Y.

In Canada—The Canadian Kellogg Company, Limited, at Toronto and Edmonton
In Europe—Kellogg International Corporation, at London

KELLOGG — DESIGNED BY PULLMAN

*Trade-mark of The M. W. Kellogg Company

KELLOGG
HIGH TEMPERATURE
HIGH PRESSURE
POWER PIPING
KELLOGG
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HIGH TEMPERATURE
HIGH PRESSURE
POWER PIPING

Stainless-Clad Steel Coal Shows No Wear After 9½ Years

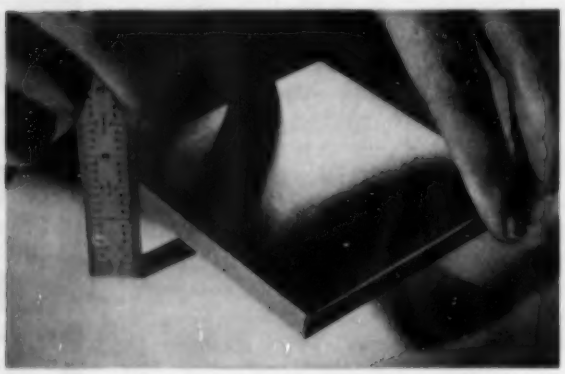
After 9½ years of continuous service without repairs, hopper #634 in Niagara Mohawk Power Corporation's Huntley Station has been removed for laboratory evaluation—still in perfect condition. This hopper, made of stainless-clad steel, had been installed in 1945 in an attempt to solve the problems of stoppages and hangups that cut into operating schedules and to relieve an expensive maintenance headache.

Its in-service record here proved Type 304 stainless-clad steel's economy and efficiency in withstanding the inevitable sulphuric acid corrosion and abrasive wear of moist coal. Laboratory examination of the hopper showed no measurable loss of gage, no repairs, and a far smoother interior surface than at the time of installation. Because of the exceptional performance of stainless-clad steel in this test hopper, it has since been specified for other coal handling equipment on the Niagara Mohawk system.

The reason is simple. Carbon steels ordinarily used in coal handling equipment corrode as much as 25% a year, give very short service life. But stainless-clad steel affords *full* protection at *low* cost from corrosion and abrasion, develops a smoother surface with hard use.

Stainless-clad steel equipment means less maintenance, uninterrupted flow, and service life equal to that of a boiler. It gives you all the benefits of solid stainless plate with greater economy.

If you would like more information, write for Bulletin 740. In addition, our Technical Service Department is available to work with your equipment builders and engineers in putting stainless-clad steel to work for you. And, if you would like the names of qualified builders of clad steel coal handling equipment, write to the Manager, Marketing Service, 684 Lukens Building, Lukens Steel Company, Coatesville, Pennsylvania.



This photo shows a layer of stainless-cladding inseparably bonded by heat and pressure to the carbon backing plate. It provides the performance of the expensive solid stainless at a lower cost. In addition, clad steel can be worked by conventional fabricating tools and methods.

This is the original hopper #634, split in half as it will appear at the Power Show. Even after 9½ years of rugged service, no loss of gage could be measured by laboratory instruments. Profilometer measurements of the stainless surface finish were 6 to 7.5 micro inches, the equivalent of a highly-polished finish.

LUKENS CLAD STEELS

STAINLESS-CLAD

PRODUCER OF THE WIDEST RANGE OF TYPES AND SIZES OF CLAD STEELS AVAILABLE ANYWHERE

Hopper Service

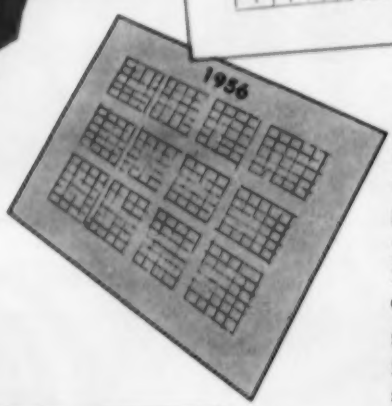
Pictured above are *four* stainless-clad steel hoppers in service at the Huntley Station of the Niagara Mohawk Power Corporation. Hopper #634 on the right is the recent replacement for the original test hopper that was removed for laboratory examination.

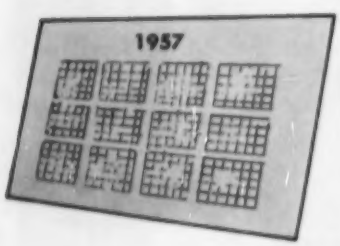
Each of the "half-soles" used in patching up this relatively new carbon steel hopper had three *avoidable* results—flow was interrupted—high maintenance charges were incurred—service life was shortened. Stainless-clad steel would have eliminated the first two, and lasted through the useful life of a boiler.

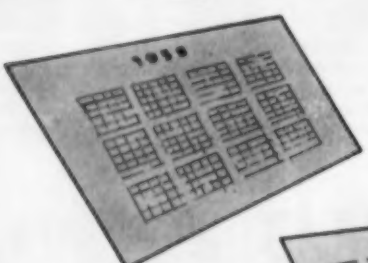
This section of carbon steel coal pipe shows hammer marks made in freeing hangups due to rat-holing and arching. Smoother, corrosion-resistant stainless-clad surfaces reduce friction, help eliminate these causes of stoppage and high maintenance expense. These coal pipes at Huntley Station are now being replaced by stainless-clad pipes.

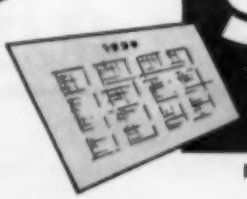
NICKEL-CLAD · INCONEL-CLAD · MONEL-CLAD

Let's face it...









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Editorials

The Plight of the Coal Industry

All long-range forecasts of the last several years including that of the Paley Commission predict a solid rate of growth for electric production, something of the order of 5 to 7 per cent annually for the next twenty-five years. Along with these forecasts comes the disturbing prediction that the reserves of our traditional energy sources for such production may be sorely strained to meet these demands. As an example if the 1978 energy production were to be met by coal it would take some 525 million tons or an increase of 450 per cent of the 1953 coal figure for this use. Most observers feel the bulk of any such increased energy requirements will have to be met by coal.

With such a promising future the natural expectation would be for a bullish outlook among the coal suppliers. Yet oddly enough the situation among the coal industry is quite the reverse. Philip Sporn, in a lecture before the Supply Section of the Institute of Electrical Engineers, London, England, summed up the coal industry's dilemna quite accurately in the following statement and at the same time gave a word of caution to the power field a long time coal industry market.

"One danger which is facing the American power industry may come about as a result of the coal industry's subjection to very difficult competitive forces over the next decade, and then perhaps being asked at the end of that time, after a protracted condition of relative starvation, to pick up and do a giant's job in a national emergency."

The "relative starvation" Mr. Sporn refers to is here for the coal industry now. Their gross production in 1954, at its present rate, will approximate that of 1907 (395 million tons). Yet oddly enough the industry has done everything to meet competition. It has mechanized its mines and improved production per unit worker. In fact, in spite of the extremely high wages of the American miner, American coal is being delivered in ports along the northwestern European coast at lower overall costs than British coal mined only two to three hundred miles away.

But the coal industry's competition is much closer at hand. The other fuel sources, oil and natural gas, have succeeded in supplying most of the expanded fuel needs of America of recent years. As a result coal in many grades and markets is selling below the cost of production. Obviously a situation that cannot continue. But for the immediate future nothing seems in sight to change this picture. There have been several proposals advanced by individual coal company representatives as possible solutions but nothing of a universal appeal. Certainly the power industry should take into its reckoning the condition of one of its major suppliers and the manner in which that condition will affect future energy requirements.

A Job for Engineers Joint Council

Passage of the Atomic Energy Act of 1954 by the Congress of the United States and its signing by President Eisenhower on August 30 are events that will have an impact in many areas. With nuclear engineering removed from its previous status of nearly complete identification with government projects, the way is opened for wider participation by industry, by educational institutions and by technical societies.

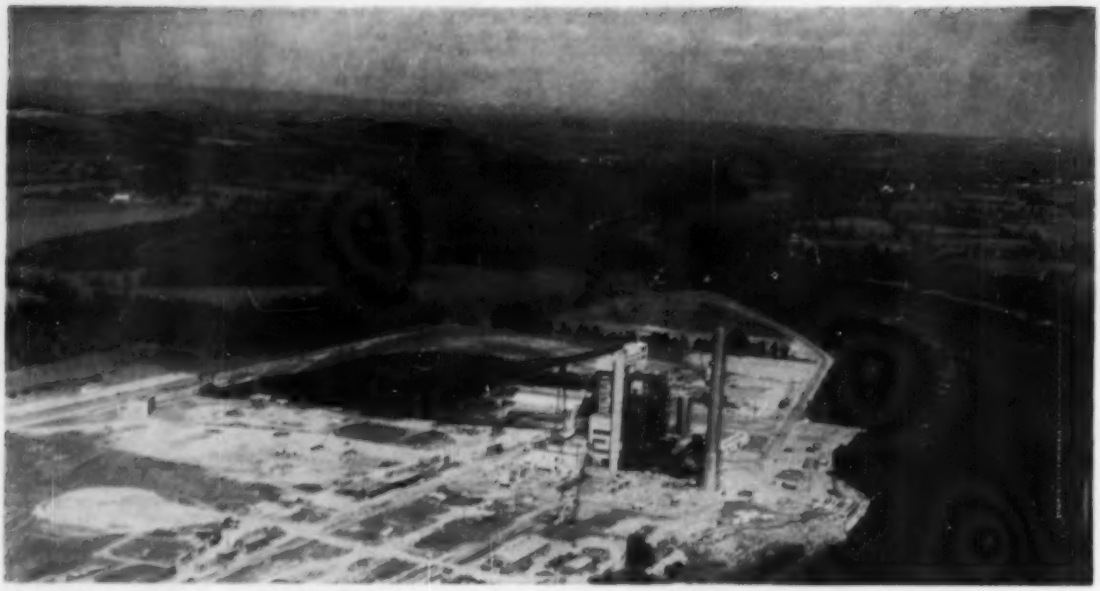
At present there exists some confusion as to the specific role that will be played by engineering organizations. Following the highly successful International Nuclear Engineering Congress held at the University of Michigan last June under the auspices of the Nuclear Engineering Division of the American Institute of Chemical Engineers, the Engineers Joint Council announced plans for a national convocation in 1955 with the program planning under the direction of its constituent societies which include AIChE, ASME, AIEE, ASCE, ASEE AWWA, and SNAME.

An invitation was also extended by EJC to the American Chemical Society and to the American Institute of Physics to participate in the planning of the 1955 nuclear convocation. Within the last month, however, complications have been added by the announcement of the formation of the American Nuclear Society which lays claim to being "the first wholly professional organization of scientists and engineers working in the atomic energy field."

Present indications are that EJC is making every effort to cooperate with the new group. Based upon past experiences in the formation of so-called splinter societies, it is greatly to be hoped that the American Nuclear Society will reciprocate by working along with existing programming agencies so as to avoid unnecessary duplication of effort in the rapidly growing nuclear field.

Meanwhile in another area more closely related to trade association activity than to professional society programming, the Atomic Industrial Forum, Inc., recently celebrated the first anniversary of its period of active operation. In that interval it has strongly established itself as a spokesman for industries directly concerned with atomic energy. It has also conducted several extremely well organized meetings on industrial participation and interpretation of the new Atomic Energy Act and is the publisher of a highly informative monthly "Forum Memo" for its members.

With this assurance of wider participation by industry and the successful operation of the Atomic Industrial Forum, what remains is for the engineering societies to get together and continue the flow of technical information as they do in other related fields. To further this objective cooperative efforts through the Engineers Joint Council appear to be the most desirable.



Aerial view of Martins Creek Steam Electric Station

The Martins Creek Steam Electric Station of the Pennsylvania Power & Light Company

By M. D. ENGLE and S. C. TOWNSEND

Pennsylvania Power & Light Company

THE Pennsylvania Power & Light Company and its subsidiary, The Scranton Electric Co., occupy an area in central-eastern Pennsylvania of roughly 10,000 square miles. This area is highly diversified and includes practically all of the anthracite mining in the country, many heavy industrial centers, such as Bethlehem with its large steel mills, the rich cement regions, fertile farming lands in Lancaster and the Susquehanna Valley and mountainous resort country through the Poconos and the northern tier. There are only two cities of over 100,000 population, Allentown and Scranton, and only a handful of more than 20,000, such as Bethehem, Hazleton, Wilkes-Barre, Williamsport, Harrisburg, Lancaster and Pottsville. The bulk of the territory is comprised of rural areas and small built up communities with a total population of about 2,100,000.

The system peak load in 1953 was approximately 1,000,000 kw and the annual output was about 4,500,000,000 kwhr. Power is generated exclusively in thermal power plants with the exception of one 40,000-kw hydroelectric plant which is operated as a peak load plant from the reservoir created by Lake Wallenpaupack.

At the beginning of the postwar period in 1945, PP&L was faced with the problem of providing adequate new generating capacity for load growth and to allow the retirement of a number of old, small, high cost generating stations. In the interval from 1945 to the present time, steam electric station generating capacity has been practically doubled, including relatively large high-pressure, high-temperature units in the Stanton, Suburban and Sunbury plants.

With its large amount of low cost anthracite-fueled generating capacity, the company finds itself in a unique situation among utilities because of the wide differential in fuel costs as between low cost anthracite delivered at Sunbury, Suburban and Stanton and high-cost bituminous delivered in the east. This fuel cost differential results in a situation where all of the base load capacity is at existing stations and the new capacity can only be peak load capacity for some

In this article, adapted from a paper presented before the Middle Eastern District Meeting of the American Institute of Electrical Engineers on October 5 at Reading, Penna., the authors enumerate some of the considerations in designing an outdoor, low-load-factor central station. Among the many unusual features are the outdoor design of the water treating plant, use of a heavy-duty crawler-type crane for handling outdoor equipment, and the employment of a seismic refraction survey to determine depth of bed rock at the station site.

years to come. Careful load and cost studies have indicated that Units No. 1 and 2 at the new Martins Creek Station will operate some 4000 hours per year. When additional base load capacity is required some years hence, it will then be installed, probably in the form of large high-pressure, high-temperature reheat units.

On the basis of the new capacity being peak capacity probably for the life of the units, it became necessary to develop plans to construct a station with lowest overall cost per kilowatt, consistent with low manpower and operating cost results.

Long range studies have shown that for an interconnected system like PP&L's, stations should be installed which are capable of expansions to at least 1,000,000 kw capacity. In the eastern part of the Company's territory only the Delaware Valley meets the requirements of an adequate water supply close to large load centers and reasonable freight rates on fuel.

An extensive study revealed only three sites along the Delaware between Riegelsville and Port Jervis, which could be developed for the size contemplated. The most favorable of these sites is the Martins Creek site.

Extensive studies were made as to the size of the first two units, the use of reheat and selection of steam pressure and temperature conditions. These studies indicated that units of essentially the same capacity as No. 4 at the Sunbury Station were a logical choice. However, because low investment costs were more important than an extremely economical unit, the higher pressure and reheat cycle employed on Sunbury No. 4 could not be justified.

General Description

The Martins Creek Steam Electric Station occupies a 450 acre site on the west bank of the Delaware River approximately 3 miles upstream from the village of Martins Creek, Penna. In the initial installation there is one 132,500-kw turbine-generator supplied by one 1,200,000-lb per hour steam generator using pulverized bituminous coal as the principal fuel. Steam conditions at the throttle are 1250 psig and 950 F. The auxiliaries for the station are supplied from a transformer off the generator leads and the output of the unit is stepped up to 66-kv through a single three-phase transformer which connects to the 66-kv switchyard.

No. 2 unit, now on order, will be a duplicate of No.1 unit, except that the output will be stepped up to 220 kv and the first section of the 220-kv switchyard will be built. No. 1 unit was placed in operation in 1954 and No. 2 unit is scheduled for 1956.

The first two units at Martins Creek are designed for low load factor operation as the base load of the system will be carried by the Sunbury Station on the Susquehanna River. Sunbury burns the lower cost steam sizes of anthracite and bituminous coal and is in lower freight zones for both fuels than is Martins Creek.

The extremely low load factor at which the first two units in the station are expected to operate was a major consideration throughout the design. The moderate steam pressure and temperature, the lack of reheat, the small size of condenser, etc., were all dictated by this factor, with a considerable saving in the cost of construction. Furthermore, since the spinning reserve on the interconnected system is greater than is economical during the night shift and over week ends, these two units at Martins Creek are designed and instrumented so that they may be shut down each night and over week ends and quickly started in the morning when required by the load buildup on the interconnected system.

The station has been designed for minimum operating personnel by centralized control, complete automatic controls, complete instrumentation and few operating levels.

Civil and Architectural Features

Architecturally the station is of the "outdoor" design where only the principal operating areas are enclosed. The balance of the station equipment is installed out of doors without enclosures. By the utilization of this design a substantial saving in the cost of construction has been accomplished without reducing the reliability of the equipment installed.

Along with the initial 132,500-kw installation a considerable amount of construction was completed which will be adequate for the second 132,500-kw unit and a smaller amount for future units. However, wherever possible, construction for units beyond No. 2 was held to a minimum. The intake structure and circulating water discharge conduit and the gunite lined steel chimney will suffice for Units 1 and 2. The coal handling equipment and ash disposal area will be sufficient for three or four units.

Foundations and Seismic Survey

Comprehensive subsurface exploration work was done. The depth of the rock below the surface of the site was determined by a seismic refraction survey and checked by a few wash borings through the overburden and core borings into the rock below.

The seismic refraction method of determining the depth of rock below the surface utilizes 12 seismometers placed in a line in the surface of the ground. A charge of dynamite is exploded below the surface first at one end of the line and then at the other end of the line. From the curves drawn by the recording oscillographs connected to each seismometer, the depth of the rock below the surface is determined.

The survey showed the elevation of the bedrock to be from 12 to 50 ft below the surface with an average of about 35 ft. The bedrock is mainly a soft limestone although seismic velocities demonstrated that some relatively harder strata are interbedded. Above the bedrock there were found strata of boulders, gravel and sand grading into heavier concentrations of gravel and sand. The upper 8 to 12 ft is composed of river laid sand, silt, and loam.

Tests of the overburden revealed it to be suitable for railroad embankments and earth dikes for the ash disposal area. Soil bearing tests on the boulder, gravel and sand strata showed high bearing strength suitable for foundation mats and spread footings for the various structures.

For these subsurface conditions, it would have been very expensive to carry the foundations to rock because the boulder, gravel and sand strata above are porous and the cost of dewatering would have been high and unpredictable.

By accepting a somewhat higher head on the circulating water pumps, the main foundations could be carried on a concrete mat for certain foundations and individual

spread footings for the other foundations, all located on the boulder, gravel and sand strata. Dewatering expense was eliminated except for the intake and car unloading hopper, the discharge conduit was located closer to the surface and the non-recoverable siphonic head was utilized to reduce the size of the discharge conduit required to return the water to the river below the natural dam in the river.

An economic study showed that a deeper turbine basement level, to reduce the head required by the circulating water pumps, could not be justified for the subsoil conditions found at the station site. Nor could it be justified to locate the turbine basement at yard grade.

Hydrography

The water supply for all purposes at the station is obtained from the Delaware River. The drainage area of the river above the station site is approximately 4535 square miles. The United States Geological Survey since October 1922 has maintained a stream flow gaging station at Belvidere, N.J., about 2.5 miles upstream from the site. During the period of record the mimimum flow was 609 cu ft per sec.

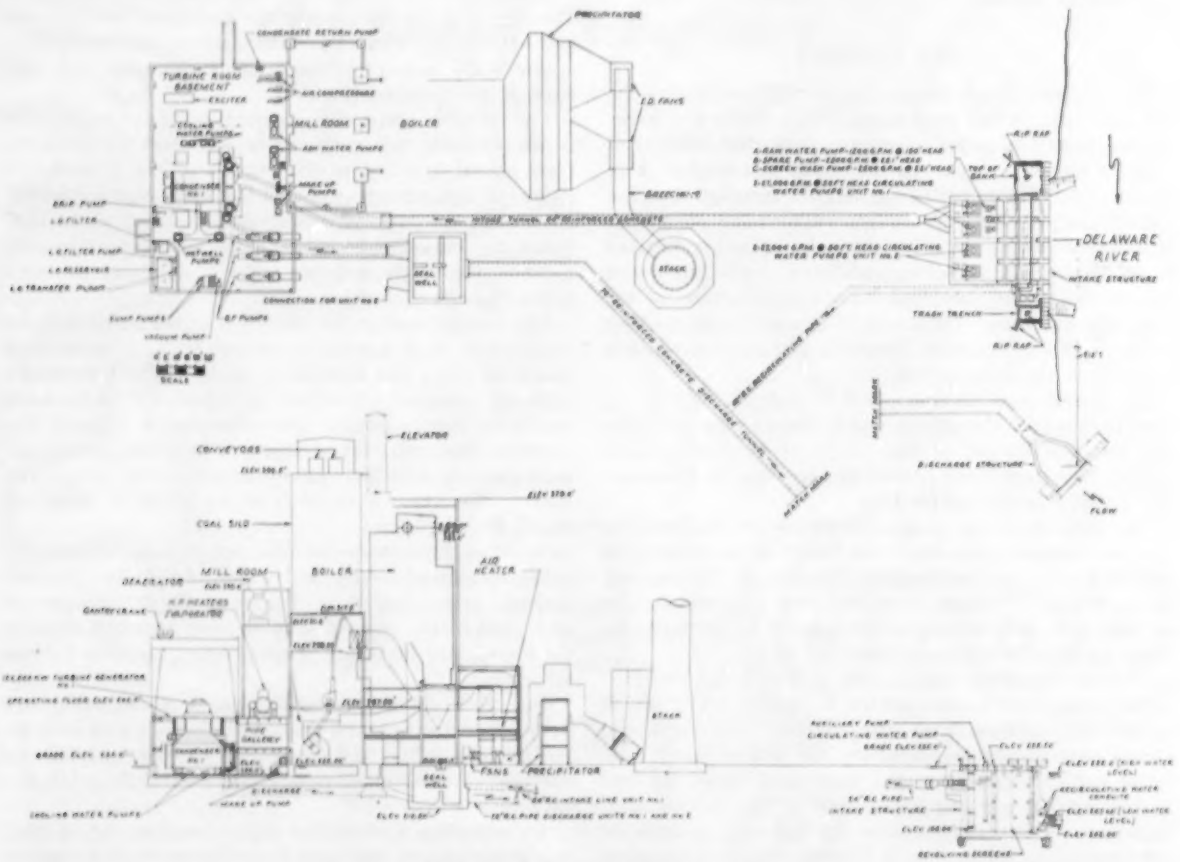
The City of New York has under construction the Pepacton Reservoir on the East Branch of the Delaware River and the Neversink Reservoir on Neversink River, a tributary of the Delaware River, for water supply. When these are completed in 1954, the flow of the river will be regulated to result in a minimum flow at the station site of 852 cu ft per sec. This will be sufficient for a station of approximately 1,000,000 kw. Other reservoirs are planned in the near future which will further increase the mimimum flow in the river and increase the capacity of the station at times of minimum flow.

Provisions are made for chlorinating the condenser circulating water to control algae growth, and for coagulating and filtering the water for fire protection and certain cooling uses. Make-up water for the boilers will be coagulated, filtered, softened and distilled. Potable and sanitary water will be coagulated, filtered, softened and chlorinated.

The river channel at the station site forms a long shallow pool having a depth of approximately 5.6 ft at times of minimum flow. At the site there is a natural dam in the river with rapids below. By taking the water from the river above this natural dam and discharging it below the dam, recirculation of the discharge water back to the intakes will be avoided.

Raw Water Facilities

River water enters the four screen bays of the outdoor intake structure, upstream from the natural dam in the river, through four openings in the river wall. Trash racks, trash rake, traveling screens, screen wash pumps, raw water pumps and four vertical circulating water pumps are located at the intake structure.



General arrangement of No. 1 Unit

The normal operation of the screens wash pumps is automatically controlled by a time clock which can be reset to suit river conditions. An emergency device is provided to start the screens and screen wash pump if the differential across the screens exceeds a predetermined value.

Incoming water, after passing through the bar racks and traveling screens, is picked up by the raw water pumps and by two vertical circulating water pumps for each of the two condensers. The circulating water flows to each condenser through a 54-in. underground conduit. The conduits between the intake and the station are lock-joint reinforced concrete pipe and are steel pipe buried in concrete beneath the station mat.

The two condensers discharge to a seal well just outside the station wall through 54-in. steel pipe buried in concrete. From the seal well, a single 72-in. lock-joint reinforced concrete conduit returns the circulating water from the two units to the river below the natural dam.

A gravity recirculation line from the discharge conduit to the intake slots in the river wall of the intake structure provide means for heating the river water a few degrees when the temperature of the river is such that frazil and anchor ice may form on the bar racks and traveling screens.

Outdoor Design

Although the major equipment and many of the principal auxiliaries are installed out of doors, the auxiliaries and controls which require protection from the weather have either been installed inside enclosures or provided with removable covers which are kept above freezing temperatures with small electric heaters.

It was found that considerable equipment and controls normally installed out of doors in "outdoor" stations can just as well be installed inside By locating the feed water regulators on the inlet side of the high pressure heaters, they are inside above the boiler feed pumps. By extending the drain pipes from the high-pressure heaters and evaporator coils, the drain receivers and controls are located inside below the turbine operating deck.

The omission of the buildings for enclosing the major generating equipment, auxiliaries, coal bunkers, ducts, breechings, piping, etc., has resulted in a substantial saving in the cost of the station. The enclosures provided will protect the operators who are normally inside in an enclosed station, except for those who patrol such equipment as intake screen, forced and induced draft fans, and who sluice the ashes from the ash pit below the furnace.

The office and service building, enclosures under the turbine operating deck and coal bunker support slab, water treatment plant, precipitator control building, yard service building and relay houses, are all built of 12-in. Waylite concrete blocks. A careful study of the many possible wall constructions showed the concrete block to be the most economical and this construction has therefore been used for all buildings.

The enclosure for the conveyor belts and crusher house is of maroon galbestos and the enclosure over the coal bunkers and around the elevator is corrugated asbestos-cement siding.

Offices, laboratory, meeting room, locker and shower rooms, shops, storeroom and first-aid room are all concentrated in the office and service building. Offices will be on the second floor of the front of the building and the balance of facilities on the first floor. The building is so designed that the second floor office space can be extended over the storeroom when required and the locker and shower room, shops and storeroom are so laid out on the first floor that any one can be extended as required, without necessarily extending the others.

Features of Design Adopted to Reduce Unit Cost of Construction

★

Unit design with no cross connections for high-pressure steam and boiler feed.

Outdoor design of coal fired station.

Outdoor design of intake structure.

Use of natural dam in river to prevent recirculation of condensing water.

Use of seal well considerably higher than normal river level to utilize non-recoverable head on condenser outlets to push discharge water through a smaller than normal discharge conduit.

Use of one discharge conduit and discharge structure for two units.

Use of reinforced concrete and steel pipe circulating water conduits.

Outdoor design of water treating plant.

Standpipe for condensate storage.

Standpipe for filtered water storage.

Minimum subsurface construction.

Condenser basement 5 ft below yard grade.

Concrete block walls for all major structures on the property

Concrete silo coal bunkers, outdoor supporting conveyors and conveyor house.

Use of gravel surface for operating area and under boiler and outdoor auxiliaries.

Boiler maximum continuous capacity the same as maximum guaranteed steam flow to the turbine throttle.

Two Schedule 160 steam lines from superheater to turbine in place of one forged and bored line.

Wet ash hopper and jet pulsion pumps for ash and dust handling.

Use of one chimney for two boilers.

Maximum rating for standard 125,000-kw turbine generator.

Small size of condenser and circulating pumps.

Raw river water to oil and hydrogen coolers of turbine generator.

Coal car unloading hopper also used as reclaiming hopper for coal from storage.

Large heavy duty caterpillar crane for handling outdoor equipment, heated enclosures over equipment, etc.

Omission of spare exciter.

A single 4000 volt auxiliary bus.

Buried grounding system of steel bars instead of copper. Structural steel frame is grounding system.

Single oil-circuit breaker per generator and per line in 66-kv switchyard (operating and inspection bus).

Highway oil trailer in place of buried oil piping system for transformer and oil-circuit breaker.

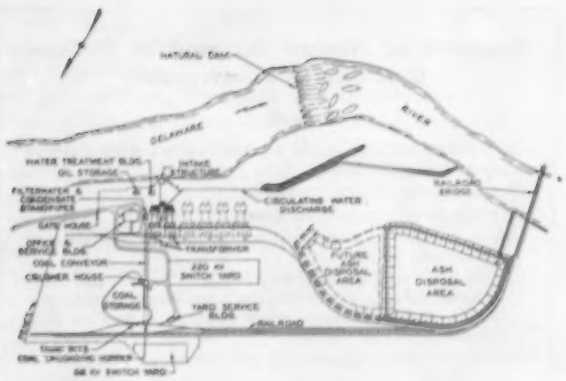
Single control room for

(a) Full control of first two units.
(b) Control of all generators in ultimate station.
(c) Supervisory control of 220- and 66-kv switchyards for ultimate station.

Omission of start and stop buttons at many motors. Only control in control room.

Single three-phase transformer for stepping up full capacity of generator to transmission voltage.

Delivery of No. 1 generator output to 66-kv transmission system eliminates necessity for additional 220/66 kv step-down capacity.



Map showing operating area

The control room will be a separate building located on the turbine operating deck. With the installation of Unit 2, this building will be extended to provide an office for the operating engineer.

Dismantling Crane

In place of the many monorails and monorail structures usually provided for maintenance, it is proposed to use a large caterpillar crane at Martins Creek. It will be used for handling the bar racks, screens and pumps at the intake, induced and forced draft fans, chlorine bottles, coagulator and filter parts, outdoor pumps, oil circuit breakers, transformer bushings and similar equipment.

The crushed gravel yard surface will permit this crane to maneuver wherever desired.

Mechanical Features

Since the first two units in the station are to operate at low load factor, a number of the mechanical features are somewhat different than would be found in a station designed for high-load-factor operation.

The steam conditions at the throttle of 1250 psig, 950 F were dictated by the desire to obtain low unit cost of construction rather than high thermal efficiency. To have used a lower steam pressure would have required the use of a smaller 3600 rpm turbine generator at higher cost per kilowatt. Higher steam pressures or temperatures or reheat could not be justified economically

Since the units will be operated at full load for only a few hours per year, the condensers are probably the smallest for the size of the unit ever installed and the turbines are designed for satisfactory operation at a back pressure of 4-in. Hg.

Other features dictated by the expected low load factor operation are:

1. Five stage extraction with no drain coolers.
2. Raw river water to oil and hydrogen coolers.
3. Maximum continuous boiler steam output the same as the maximum guaranteed throttle flow to the turbine.
4. Constant-speed, vane-controlled, induced and forced draft fans.

Features of design for high availability are:

1. Completely water-cooled furnace of liberal size.
2. Wide spacing of boiler and superheater tubes.
3. Steam heaters on air inlets to air heaters to reduce fouling.
4. Ball tube mill pulverizers.
5. Two one-half size units for almost all main auxiliaries.
6. Recirculation system to prevent formation of frazil or anchor ice on intake bar racks and traveling screens.
7. Motor-operated rack rake for removing debris from intake racks.

Fuel

The first two installations at Martins Creek are designed to burn bituminous coal. Because of the low load factor, the higher cost of facilities for burning anthracite or bituminous-anthracite mixtures could not be justified.

Furthermore, recent studies have shown that with the expected anthracite mining operation during the life of power boilers being installed now, an adequate supply of the steam sizes of anthracite for the life of such boilers is not likely. It appears that before many years, the presently installed anthracite fired boilers will consume more than produced by new mining operations and recovered from existing silt banks.

Coal Handling and Storage

Bituminous coal will be received at the station yard in 50 to 70 ton cars and will be handled by a single 65-ton, two-engine diesel switching locomotive. Coal will be unloaded into a 160-ton track hopper assisted by a car shake-out. With the design developed it is believed that under normal conditions 600 tons per hour can be unloaded. The layout is such that a car dumper can be added when justified. Oil-fired thaw pits are provided on the railroad track upstream from the car unloading pit.

A single conveyor of 600 tons-per-hour capacity will deliver the coal from the track hopper either to storage or to the coal conveyor over the bunkers. Provisions are made for the addition of a second conveyor in the future. A magnetic pulley will remove magnetic material from the coal and the coal will be weighed in transit by a weightometer.

Coal will be discharged to storage by an inclined conveyor at the crusher house and will be stored by bull-

Features of Design Adopted to Defer Investment for Units Beyond No. 2

★

Intake structure for two units only.

Discharge conduit and structures for two units.

One coagulator and one filter for raw water. Filtered water standpipe provides for outages for maintenance.

Yard fill for one unit only.

Fencing of operating area for two units only.

Railroad yard for two units only.

Coal unloading hopper and shake-out designed to unload 600 tons per hour to defer investment in car dumper.

Support and enclosure for second conveyor belt from crusher house to bunkers deferred.

Ash disposal area dykes for moderate capacity. Additional areas to be dyked as required.

Small size office and service building designed for extension of offices, locker and shower rooms, shops, or storeroom when required.

dozers at present and carryalls in the future. When coal is reclaimed from storage, these bulldozers and carryalls will deliver it to the same unloading hopper as used for unloading railroad cars and the same belts will deliver the coal to the bunkers.

Two concrete silo coal bunkers are provided for each unit. They are 36 ft in dia by 75 ft high and provide 2400 tons of storage for each unit, good for operation at full load for 40 hours. Each silo will supply one pulverizer through two 30 in. dia outlets so designed as to result in practically no hangup in the bunkers and requiring no hand trimming. Because of the danger of explosions in closed bunkers, the tops of these silos will be open to the coal conveyor and tripper gallery above.

A yard service building, closely adjacent to the railroad yard and car unloading hopper will provide a locomotive and mobile-coal-handling-equipment shop, locker room, shower room and lunch room for the coal handling personnel and offices for the coal handling foreman.

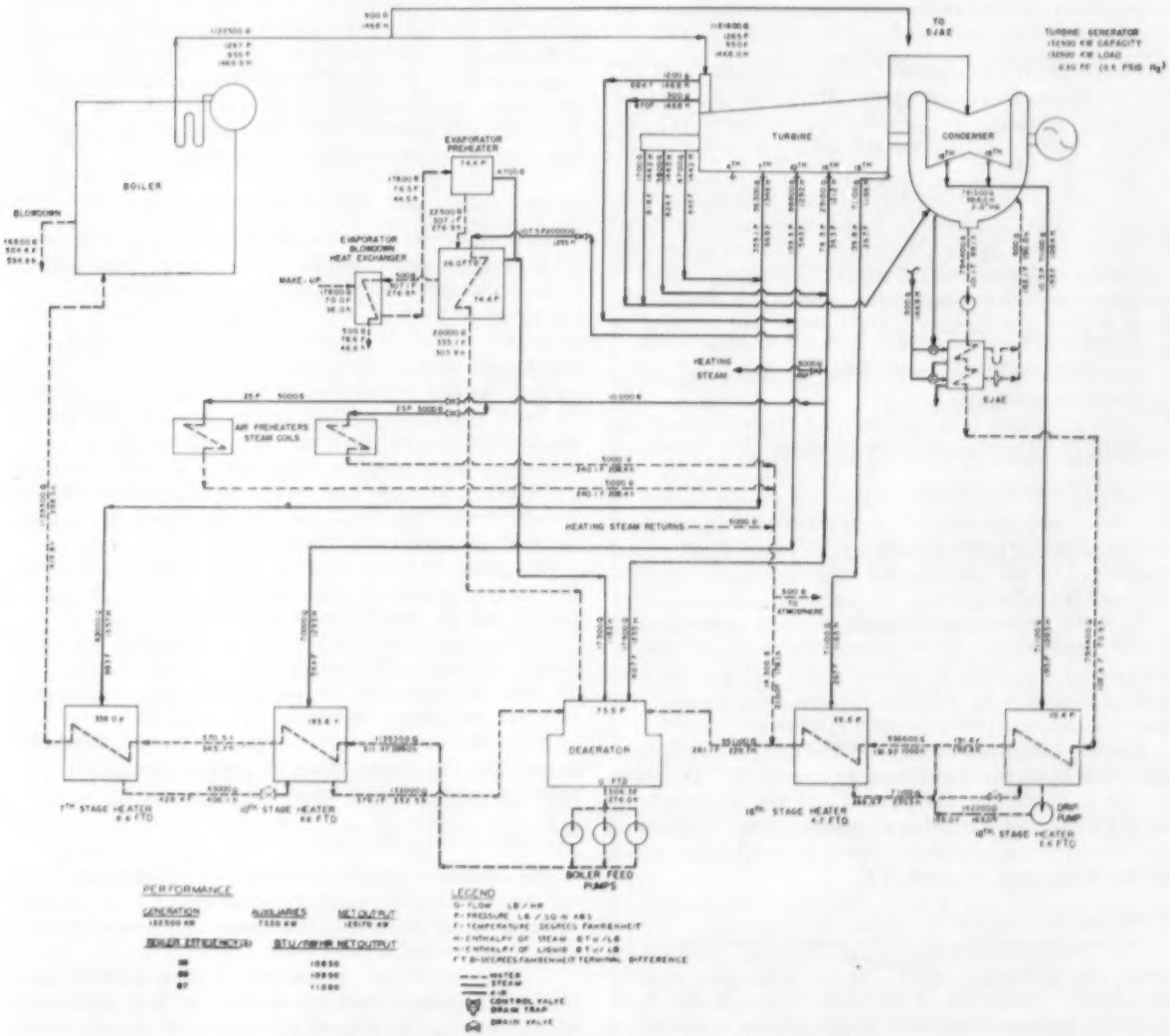
Steam Generating Equipment

One steam generating unit will be provided for each unit without high-pressure steam or feedwater cross ties. This unit type of construction reduces capital cost, simplifies operation and increases reliability. Each Foster Wheeler unit is designed for 1,200,000 lb of steam per hour at 1550 psig, 955 F.

The superheater will be of the combination radiant-convection design with a new design of superheater control condenser to give constant steam temperature over a wide range in load. The superheaters are of the pendant type but can be drained completely. The convection boiler section is built of bare tubes while the economizer will have extended surface formed by cast-iron gill rings shrunk on the steel tubes.

Two 119,000 sq ft regenerative-type air heaters which are provided for each boiler are designed to heat all of the air for combustion to 600 F at full load. Finned-tube steam heaters are provided to heat the cold air to the air heaters to prevent condensation on the cold end of the air heater elements and thus to prevent fouling with corrosion products and flue dust.

The furnace is approximately 50 ft wide by 26 ft deep and is nearly 89 ft high, which gives an effective volume



Heat balance diagram for 132,500-kw load at 2-in. Hg abs

Features of Design Adopted to Reduce to a Minimum the Number of Operating Men Required per Unit of Station Capacity

★

Large size units.

Full automatic control.

Centralized control room for main units and major auxiliaries and 66- and 220-kv switchyards.

Large heavy-duty caterpillar crane for handling outdoor equipment, heated enclosures over equipment, etc.

Concrete silo coal bunkers which require minimum hand trimming.

Vertical coal pipes, 30 in. in dia, to 60 deg conical hopper on feeders and other feeder modifications to reduce coal flow stoppages to a minimum.

Oil-fired car thaw pits to speed up the unloading of coal cars in freezing water.

Recirculation line from discharge conduit to intake to thaw frazil and anchor ice on bar racks and screens.

Automatic operation of intake screens and screen wash pumps by time clock and differential recorder controller.

Refrigerators and grills for lunches at principal operating locations.

of 105,000 cu. ft., This results in a heat release of 14,200 Btu per hr per cu ft and 85,000 Btu per hr per sq ft of projected surface. To obtain the required exposed surface, the furnace will be divided by a center water-cooled wall.

Coal will be pulverized by two ball tube pulverizers, fed at each end by a table feeder automatically controlled by the coal level in the pulverizer. Two exhausters per pulverizer (4 per boiler) will supply pulverized coal to 12 horizontal turbulent burners mounted in two rows in the front wall of the furnace. Oil torches will be used as igniters.

Flue dust will be removed from the flue gases by an electrostatic precipitator.

The two forced and two induced draft fans will be constant speed and inlet vane controlled.

Ash and Dust Handling

Refuse from the wet ash hoppers below the furnaces will be removed hydraulically by jet pulsion pumps and discharged to the ash disposal area approximately 2400 ft from Unit 1.

Dust will be removed from the hoppers of the electrostatic precipitators and economizer and air heater pockets by a pneumatic system which will wet the dust and discharge it to the ash disposal area through the same pipeline used for the ash hopper ash.

The ash disposal area is diked and designed to remove the solids from the water used to convey it. The dikes are 10 ft above the yard grade and the area enclosed should suffice for a number of years. There is space on the property for additional diked disposal areas which will be built when required.

Turbine-Generators

The two 132,500-kw General Electric turbines are 3600-rpm 1250-psig, 950-F tandem-compound double-flow units. There are 16 stages in the single-flow high-pressure elements and four stages in the low-pressure double-flow elements. There are five points for extraction of steam for feedwater heating and evaporating the makeup.

The two low-pressure heaters in the condenser neck are connected to the 16th and 18th stages. The 14th stage provides steam to the open-type deaerating feedwater heater and hot-water storage tank on the boiler feed pump suctions. The two high-pressure heaters are connected to the 7th and 10th stages. Steam for the evaporator is taken from the 10th stage and the vapor is condensed in the deaerating heater. Steam for building heating and for the air heaters on the air heater inlets is taken from the same extraction point as the deaerating heater.

Water level in the deaerating heater is maintained by bypassing part of the hotwell pump discharge to the condensate storage standpipe whenever the level in the deaerator storage tank is above normal and returning condensate from the condensate standpipe, by means of makeup pumps, whenever the water level in the deaerator storage tank is below normal. At normal water level the deaerator storage tank contains sufficient water to supply the boiler feed pumps for approximately 10 min at maximum continuous boiler output.

Each unit is provided with a 40,000-lb per hr evaporator in order to handle the high makeup expected because of the frequent shutdowns and startups mentioned. The evaporators are provided with bubble washers to wash the vapor with distilled water to provide the purest distilled water possible. The feed water to the evaporators is conditioned with Zeolite softeners.

Main Condensers and Auxiliaries

Each condenser is of the divided-flow type, two pass, with divided water boxes. They have welded steel shells, extended necks in which are installed the two low-pressure heaters, and cast-iron water boxes. The necks are welded to the turbine exhausts and the condensers are supported on springs.

Two vertical circulating water pumps are provided for each condenser. They are installed at the water intake structure at the river edge and supply water to the condenser through a single intake conduit for each condenser. The 54 in. conduit is of steel below the turbine room basement and concrete lock joint pipe between the intake and station.

One pump running alone is adequate for full load on the turbine except in the warmest weather but two pumps will be operated normally.

Two vertical hotwell pumps are provided for each condenser, each adequate for full turbine load. The air removal equipment for each condenser consists of a twin jet, two-stage, steam jet air pump with inter and after condensers. Two priming jets are provided for evacuating the steam space and water spaces and circulating water pipes of the condenser.

Cooling Water Systems

The oil coolers and hydrogen coolers of the main unit will be cooled with raw river water taken from the circulating water system of the main condenser through twin strainers and booster pumps.

Cooling water for pulverizer bearings, boiler feed pump oil coolers, and compressor jackets and after coolers will be taken from the filtered water standpipe and returned to the same standpipe.

Compressed Air Systems

Compressed air for general station use is supplied by two air compressors, one installed with each unit. A portable gasoline engine operated compressor will be provided to act as a spare and to furnish compressed air for the many locations where it is not economical to have permanently piped outlets.

Compressed air for actuating the numerous pneumatic control devices will be supplied by three carbon ring compressors for the two units. One for each unit for normal operation and one automatic spare for the two units. Control air will be filtered and dried before use.

In emergency, station service air can be used as control air.

Centralized Automatic Controls

The station has been designed for minimum operating personnel. To accomplish this, automatic controls have been installed to the fullest extent and the controls of the main units and principal auxiliaries have been centralized in one control room for the two units. In addition to this, the control room for Units 1 and 2 will contain the controls for all generators in the ultimate station and supervisory control for the 66-kv and 220-kv switchyards for the ultimate station. This control room will also contain the load control equipment for all units.

The exceptions to centralized control are:

Coal-handling equipment which will be controlled from the crusher house.

Electrostatic precipitators in separate building for each unit close to the precipitators.

Ash and dust handling controls in the pulverizer rooms for each boiler.

Soot blowing in the coal feeder and burner rooms below the coal bunkers for each unit.

Water treatment plant control will be located at several points as follows:

(*a*) Raw water coagulators and filters and chlorination equipment for circulating water in a separate building at the river bank adjacent to the equipment.

(*b*) Zeolite softeners, hypochlorite feeders for potable water, phosphate, sulfite and caustic mixing tanks and feeder pumps, under the sloping floor of the furnace adjacent to the pulverizers of each boiler.

(*c*) Evaporator control in the turbine basement below each of the evaporators.

By placing the above mentioned controls at these strategic locations it is believed that the control functions will be more properly spread among the operating personnel and will result in better supervision of the controls and lower cost of installation.

Heating and Ventilating

With the outdoor design of station, the heating and ventilating problem is very much simplified. The control room and station service building offices will be air conditioned.

Separate fans are installed to provide forced ventilation to the following enclosed spaces:

(*a*) Turbine basement below operating deck.

(*b*) Pulverizer room.

(*c*) Feeder and burner floor.

Heating in these spaces will be provided by unit heater taking steam either from the extraction steam line to the deaerator or from an oil-fired package boiler.

Forced ventilation and electric heaters will be provided for the crusher house control room and electrostatic precipitator control houses.

Removable enclosures around certain equipment installed out of doors will be provided with electric heaters to prevent freezing. Pipelines which are installed out of doors and which will be subject to freezing are provided with electric heating cables, insulated and weatherproofed.

Generators

Generators No. 1 and No. 2 are duplicates, each being an 18,000-volt, 3600-rpm conventional hydrogen-cooled unit rated 147,000 kva at 0.5 psig hydrogen pressure with supplemental ratings of 169,000 at 15-psig and 184,000 kva at 30-psig operation. No. 1 unit will probably operate in the 15 psig rating range and No. 2 unit closer to the maximum rating because of a greater demand for reactive supply on the 220-kv system. Each generator is grounded through a distribution transformer having a resistor loaded secondary. Ground faults will not trip the machine but will operate an alarm.

Generator, main generator transformer, station auxiliary transformer and leads to and including the 66 kv oil-circuit breaker are protected by one overall differential protection system rather than by several systems as has been previous practice.

Excitation is being supplied by a high-inertia-type motor-generator set at 375 volts d-c. Motor-generator sets have been standard with PP&L in the postwar period and a careful study of the general performance, industry wide, revealed no reason to change this practice. No spare exciter is being provided. The excitation control employs the familiar amplidyne system.

Features of Design Adopted for Personnel and Equipment Safety

★

Central control room sealed off from all other enclosed spaces so that fires and smoke will not require operators to leave control room.

Outside controls for ventilating fans so that they may be shut down in case of fire.

Provisions made so that hydrogen may be vented from generator in case of trouble from outside of condenser basement.

Gasoline engine driven fire pump outside station enclosures.

Gasoline engine driven sump pump outside station enclosures for dewatering turbine basement.

Fog nozzle system automatically operated for fire suppression in condenser basement at oil reservoir, hydrogen seal unit and below front end of turbine.

Hydrogen bottles located out of doors and piped to generators.

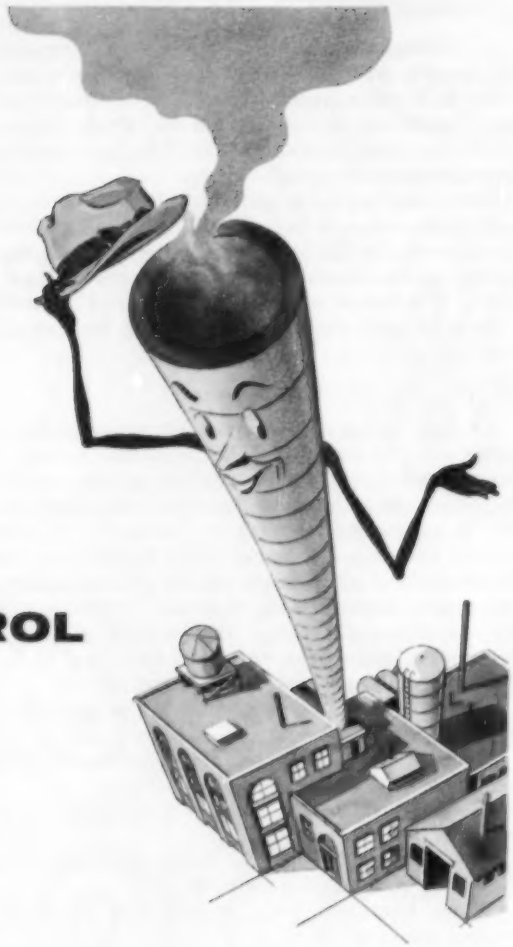
Other Features of Design

★

Units designed for shutting down at night and over week ends and quick starting when required for service. This provides time for maintenance and makes it possible to eliminate some spare auxiliaries.

Units designed to operate at 20 per cent to 40 per cent annual capacity factor.

Seismic refraction survey to determine depth of bed rock.



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Fifteenth Annual Water Conference

CLOSE to 500 chemists and engineers from all parts of the country and some from abroad attended the Fifteenth Annual Water Conference sponsored by the Engineers' Society of Western Pennsylvania at the Hotel William Penn, Pittsburgh, Pa., October 19–21. (See box for further details.)

Each of the six sessions comprising the three-day meeting were well attended and, as usual, considerable emphasis and program time were allotted to discussion of the individual papers. Of recent years the sponsors have scheduled one full session to panel treatment of a current water treatment application. This year's session was on demineralization and is reported under that heading in the meeting abstracts which appear below.

Water Availability

From a nationwide standpoint our country is blessed with plenty of water but its distribution is not in accordance with our needs. For continued industrial growth it becomes necessary to study and evaluate our natural water resources. The various factors that need evaluation were advanced by **S. R. Love,** Chief, Water Quality Branch, U. S. Geological Survey, in the paper "Industrial Water Supplies in the United States."

Precipitation is responsible for essentially all the existing supplies of fresh water. The average annual amount is 30 in. but it varies from 5 in. in some arid sections to over 150 in. in parts of the Olympic peninsula in Washington.

The average annual discharge of surface waters into the sea amounts to 8.5 in. or about 28 per cent of the annual precipitation. A substantial portion of this discharge is flood flow in such volumes that storage is not feasible. Further a considerable share of the low flow must be left untouched to serve for other needs such as hydroelectric power generation, and maintenance of navigation. As a result much of the 8.5 in. cannot be consumed in industrial processes. But some dependable yield must be relied upon. Such a yield must be determined by consistent records of stream flow, water analyses, effect of upstream dilutions and deletions.

Ground water is another important source of water. The water so stored is probably several times the volume of fresh water in lakes and rivers. But the nature of the reservoir rocks decides how much and how well an area serves for ground water storage. The arid Southwest, for example, has sandstone and limestone reservoirs holding vast quantities of water. The dense crystalline rocks of the Canadian Shield and similar formations in the humid eastern states are numbered among the poorest ground water aquifers. But, unfortunately, the continued usefulness of underground aquifers must be related to the area precipitation if man is to draw heavily upon them. The problem, then, for future industrial growth is to control the location of industry to an extent that it will not overdraw the available water supplies.

Quality of water probably stands next in importance to quantity. The nature of the soils the streams flow over, the rate of flow, the nature of tributary streams, the extent of ground water feed to main stream flow and man-made pollution affect this important factor in surface waters.

Ground waters have a somewhat higher but relatively uniform content of dissolved matter, a general freedom from turbidity and a nearly constant temperature. Air conditioning installations have drawn heavily on this last-named characteristic to the point where grave problems have developed in some areas. But cooling towers and recirculation point a way out of this difficulty.

The U. S. Geological Survey classifies water uses in four major divisions: withdrawal, such as irrigation, water power, domestic, industrial and municipal uses; non-withdrawal, such as navigation, recreation, waste disposal; consumptive use, where the water is evaporated or transpired such as in irrigation; and non-consumptive, such as development of power and for cooling.

The total of withdrawal use is estimated at about 170 billion gallons per day exclusive of power use with an additional 11 billion gallons a day for that purpose. Industrial water drawn from private sources in 1950 amounted to about 80 billion gallons per day with about 90 per cent surface water. Today it is probably nearer 100 billion gallons daily and may go to 210 billion gallons daily by 1975.

In view of the obvious problems of water availability as against the prospects of ever-increasing demands Mr. Love felt there was an urgent need for more data in nearly all parts of the country. In addition to these data on fresh water supplies the Saline Water Conversion Program now being conducted by the Dept. of Interior, the speaker stated, offers some definite appraisal of the various ideas proposed for getting fresh water from the sea and will give a realistic indication of their application and future worth.

Discussion

T. E. Larson, head, Chemistry Subdivision, Illinois Survey, brought out the fact that by far the greatest water resource is in the humidity of the atmosphere, a constantly moving body which is forever being replenished by evaporation. Scientifically controlled activity in this field, such as cloud seeding, will eventually evaluate this resource. But, concluded Mr. Larson, there is a need for data on not only quality and quantity but also on subsequent use, development and conservation of water.

J. F. Wilkes, Dearborn Chemical Co., repeated the

Fifteenth Annual Water Conference Proceedings

All papers together with their individual discussions are obtainable only in the official Proceedings selling at $8.50 per copy. These can be secured upon application to W. M. Porter, secy., Engineers' Society of Western Pennsylvania, Hotel William Penn, Pittsburgh, Pa.

need for data and suggested sources for analytical data of streams now widely used. One general reference he offered was the "Inventory of Published and Unpublished Chemical Analyses of Surface Waters in the Eastern United States," from notes on Hydrologic Activities, Bulletin No. 6, prepared for publication by the U. S. Geological Survey.

R. D. Hoak, Mellon Institute, felt that many of our water resource problems stem from the absence of a consistent national water policy. Political considerations and interagency competition unfortunately, in Mr. Hoak's opinion, play a dominant part in deciding questions on water resources. This is properly the province of a board of impartial water-resources technologists but such an enlightened approach is not yet in sight.

Stream Pollution

An 8-man panel was given the general subject of stream pollution to cover. Representatives of the major process industries were chosen to present their individual industry's viewpoints. The opening paper was a particularly informative one on Pennsylvania practices entitled the "Legal Aspects of the Clean Streams Program" by **R. J. Trace,** deputy attorney general, Commonwealth of Pennsylvania.

The fundamentals upon which governmental demand for clean streams is based is to have clear, usable water instead of slime, filth and poison which can result from abuse and negligence.

Pennsylvania's water control legislation dates back to 1905 when the Dept. of Health was empowered to regulate the supply of water for human consumption and disposal of sewage. Then the Administrative Code of 1923 amended in 1929 transferred the authority to the Sanitary Water Board. Mr. Trace detailed the parts of this basic law and the later Clean Streams Act. Much information was given on the overall philosophy of enforcement, the various subdivisions and their administrative function plus a salute to the coal industry in the state which the deputy attorney general described as most cooperative.

Henry F. Hebley, Pittsburgh Consolidation Coal Co., spoke appropriately on the major problems of the coal industry—mine drainage and suspended solids in water discharges from coal washeries. Acid mine water, Mr. Hebley pointed out, differs vastly from the usual pollution problem in that it is not man made. So the process continues long after a mine has been exhausted and abandoned. And since the major portion of acid drainage originates in abandoned workings where it is almost impossible to reopen for adequate treatment the problem is a serious one. Investigation at Mellon Institute over long years has yielded no spectacular panacea for dealing with this tainted water.

Dissolved solids are easier to cope with. It must be remembered though, as Mr. Hebley stated, that there is no marketable product recovered and such removal processes only add to the cost of coal washed.

H. A. Reda, staff engineer, Hall Laboratories, discussed "An Engineering Approach to Industrial Waste Water Problems." By starting out with an analytical and engineering approach to the problem much is to be gained, according to Mr. Reda. His suggested approach involved four major steps: (1) fact finding, (2) analysis of data, (3) exploration of in-plant and/or process changes, (4) selection of treatment systems for either waste disposal or recovery. Each of these steps had a number of subdivisions.

Mr. Reda traced his suggested approach through two special examples and explained some of the more salient data and their application in working out a final solution. A third example on the textile industry was advanced to point up the number of special peculiarities that beset that industry's stream pollution problems.

Dr. L. B. Cook, chief chemist, Millville Manufacturing Co., confined his remarks to the textile wastes and the specialized treatment they require to prevent their polluting streams.

Willard M. Hodge, senior fellow, Mellon Institute, began his remarks on "Steel Mill and By-Product Coke Plant Wastes" with the statement that the steel industry and its by-product coke works require air and water quantities that exceed the amounts of any one of the other raw materials used. In a survey made in 1939 the water needs were estimated at from 10 million gpd for some small mills to between 300 million to 500 million gpd. Despite these tremendous quantities little attention was given to the aqueous and gaseous effluents discharged from these plants.

Recent years have changed this picture. At the large, new Fairless Works of U. S. Steel Corp. the satisfactory treatment and disposal of the effluents were considered part and parcel of the construction costs.

Mr. Hodge proceeded to describe the major wastes of the steel industry and provided tabular listings on the methods of disposal and processes for treatment.

C. K. Reynolds, coordinator, Refinery Technology Laboratory, Gulf Oil Corp., for the oil industry; **Donald T. Jackson,** technical director, Hammermill Paper Co., for the pulp and paper industry; and **W. H. McElhaney,** Talon, Inc., for the metal industry covered the same general ground of the other industry representatives on the panel and cited their respective major stream pollution problems and the steps they take to correct or remove them from discharge waters leaving their plants.

Feedwater Studies

R. C. Adams, U. S. Naval Engineering Experiment Lab., chairman of the Joint Research Committee on Boiler Feedwater Studies, gave a brief report on that committee's activities. He stressed that the basic function of that committee was to serve as an aid to boiler operators. This function, Mr. Adams stated, cut across the lines of special interests and was not to be confused as an extension of the work of the utilities, the water consultants or the water treatment equipment manufacturers.

Monobed Demineralized

I. B. Dick, assistant chief chemical engineer, Consolidated Edison Co. of N. Y., supplied a paper entitled "Experience with Monobed Demineralization for Water Treatment for High Pressure, High Makeup Boilers." This paper dealt with the installation of four of an eventual six-operating-unit monobed demineralization system at the Waterside Plant of the author's company. Each unit, 11 ft in diam, is charged with a mixture of one-third IR-120 and two-thirds IRA-401 resins totaling 492 cu ft which amounts to a 5-ft depth in the 11-ft tanks. Flow rate will ultimately be 1000 gpm per unit.

Mr. Dick outlined the situation at Waterside where makeup was running about 40 per cent and silica content in boiler waters could reach as high as 30 to 35 ppm. In view of this situation and the attendant operating problems it could create, the decision was made to invest in an up-to-date demineralization system for the removal of silica and the reduction of blowdown.

A number of possibilities were considered. The monobed unit had particular appeal because it seemed possible to fit the required size equipment in the available space. Arrangements were made to obtain a small, commercially available mixed-bed unit and operate it on New York City water to get the required data for a satisfactory full-scale design. This pilot plant ran for over 100 cycles with no noticeable loss in anion capacity using IRA-401 and IR-120 resins.

During this pilot-plant phase, experience showed that photoelectric colorimeters that were simple and rugged enough for operator's use in the field were not sensitive enough for very low silica concentrations. Since that time the Con Edison people assembled an apparatus of their own which has worked out splendidly.

When the time came to put in the full-scale demineralization units each of the first four went into service easily and smoothly. From the beginning the units carried full load and gave treated water of fantastic purity. The separation, regeneration and remixing of the beds have been excellent. A number of tables were given to show performance results of the system.

Discussion

A. C. Reents, director of research, Illinois Water Treatment Co., supplied some of the effects the pilot-plant data had upon the selection of the resin. Pilot-plant results plus data from other installations in the field had indicated that Type II resins were not as stable as Type I. A general rule of thumb was evolved. Type I resins work best for demineralization of waters containing high percentages of weak acids to total anions. But for the preparation of water for very high pressure boilers the longer life of the Type I materials and their inherent greater basicity gives a minimum of dissolved silica in the boiler. At Waterside the initially chosen Type I resin was deemed to be too highly cross-linked and hence a lesser cross-linked resin was finally chosen.

F. McGarvey and **William Moffett,** Rohm & Haas Co., collaborated on their discussion. Their main point was to encourage the pilot-plant method of attacking a water treatment problem. They cautioned that resin manufacturers place an index of performance on their product based on laboratory conditions which are closely controlled. Pilot-plant data extend these laboratory findings to a specific installation. More or less as an aside these discussors included some tables and statistics on monobed units around the world.

T. Finnegan, Niagara Mohawk Paper Corp., recited some excellent operating experiences his concern has had with two 96-gpm automatic regenerating monobed units. His findings indicate some difficulties in separation of the exchange resins during regeneration. But by cut and try methods this difficulty has been minimized at Niagara Mohawk.

P. F. Baggish, chemical engineer, Ebasco Services, commented on some of the theory behind successful monobed operation in general. The major difficulty, as he saw it, was organic fouling and the loss of the quaternary amines after a number of cycles.

S. B. Applebaum, Cochrane Corp., substantiated these comments and suggested that all interested parties combine their efforts to establish valuable data on the identification, measurement and removal of the undesirable organic matter.

J. H. Hamor, senior chemist, Philadelphia Electric Co., advanced some operating information on his company's demineralization system.

Waterside Studies on High Pressure Boilers

M. F. Obrecht, Michigan State College, **H. H. Bickel,** Wickes Boiler Co., **J. F. Wilkes,** Dearborn Chemical Co., combined to present a paper "Waterside Studies in Experimental High Pressure Laboratory Boilers." This is the first of a series dealing with problems concerning reproducibility of results in experimental boilers, the difficulty of duplicating field conditions and the effect of water treatment on boiler conditions.

In reviewing previous work with experimental boilers the authors felt that all existing units were subject to difficulty in duplicating results on successive runs. Further, none provided for examination of replicate specimens produced in a single run while studying deposit formation, metal failure and corrosion.

Accordingly in 1951 the construction of a boiler capable of critical pressure operation and able to overcome the objections described above was undertaken. The boiler was designed by Dr. M. F. Obrecht and H. H. Bickel and built by The Wickes Boiler Co. Three radially located side-arms spaced at 120-deg intervals around a cylindrical body extend outward and upward from the body at an angle calculated to facilitate circulation. Heating elements go into each of the arms or tubes. Major portions of the boiler are made of SA-105, GR.1 forged steel. The maximum steam working pressure is 3100 psi and the boiler was tested at hydrostatic head of 4650 psi. A safety factor of five was used. Liquid capacity of the boiler is about 1.1 gallons.

Discussion

C. Jacklin, director, engineering research, National Aluminate Corp., pointed out that this latest boiler is a modification of a basic design in use for years. He went on to trace some of the history of this basic experimental boiler design and some of his first-hand experiences reported in detail at earlier Water Conferences. Mr. Jacklin singled out several reported results and raised questions on their interpretation and application.

R. C. Ulmer, manager, research dept., Combustion Engineering, Inc., also mentioned that the use of test boilers is an old one and suggested a bibliography on the subject to avoid needless duplication of effort. Dr. Ulmer mentioned certain tests under way at his company's Chattanooga Laboratories and commented favorably on the method of blowdown employed by the authors in their reported installation.

M. E. Brines, Dow Chemical Co., believed the experimental boiler offered considerable promise. He was especially impressed with the multiple arms and felt they offered a number of attractive possibilities for threshold studies, carryover and foaming problems. The major advantage was the variable heat input possibilities.

Demineralization Panel

H. C. Farmer and **V. B. Burgess,** Philadelphia Electric Co., led off the panel session on demineralization with the subject "Quality of Requirements and Sources of Water Supplied to Demineralizing Units."

The author's first direct experience with quality requirements was the fouling of cation beds in the two-stage demineralizing units at Schuylkill Station drawing a city water supply from the Schuylkill River source. This installation had no filters since city water had very little turbidity. But this little turbidity proved enough to foul the top part of the cation resin and lead to channeling of the resin bed. Subsurface washers located about one foot below the surface of the cation beds overcame this difficulty.

Later the Philadelphia Electric Co. ran into quality troubles with its monobed demineralizer using city water drawn from Delaware River sources. This plant had filters of cation resin on anthrafilt ahead of the demineralizing units. The trouble showed up during low run-off periods on the Delaware River. In these times the anion resin fouled up. After a series of exploratory tests the oxygen consumed test provided a yardstick for removal of the contaminant. The filters were charged with activated carbon and put in service. This does not completely solve the problem but it extends anion resin life.

M. E. Brines, assistant supt. of power, The Dow Chemical Co., discussed "Break-Through or Leakage Problems with Specific Pieces of Equipment" and in his paper covered a number of chemical break-through and leakage problems as well as channeling and mechanical break-throughs. High capacity cation exchangers operating on relatively clear, unfiltered water (average 3 to 5 ppm turbidity) had channeled and indicated apparent exhaustion prior to the midpoint of the cycle. Dow Chemical found in this case that prefiltration practically tripled the plant efficiency.

On the subject of cation exchange Mr. Brines reported that Lake Huron water is highly desirable for cation exchange since it has a relatively high alkalinity and low sodium content. These characteristics along with hydrochloric acid regeneration enable the cation exchangers to operate with no measurable leakage prior to sodium break-through. This exhaustion point is sharp, well defined and easily detected.

In discussing anion leakage Mr. Brines defined this problem as consisting of silica, iron, and organic matter. During the operating cycle the silica present in the deionized effluent is usually termed leakage which implies that the silica has escaped the bed without removal. But this silica leakage actually comes from two sources, the silica left in the anion exchanger bed after regeneration and that originating in the raw water supply as colloidal silica. The various possibilities that influence the increase of any of these contributing factors to anion leakage were discussed in some detail.

Mr. Brines went on to discuss abnormal causes of anion leakages as well as anion resin rinses and again covered these subjects by specific points and furnished supporting tables and graphs.

"Demineralization Regenerant Handling Problems" by **T. P. Harding,** chemist, Omaha Public Power District, suggested ways of reducing the hazards of storing, transferring and disposing of sulfuric acid and sodium hydroxide, commonly used as regenerant agents.

In a similar vein recommendations or practical suggestions were made for dilute sulfuric acid, concentrated and dilute caustic soda.

J. K. Sargent, technical advisor, Jones & Laughlin Steel Corp., drew up his paper on "Control Problems, Automatic, Semi-Manual, Interlocks and Limit Check Systems" based on the water treatment plant installed by his company to give high quality water for the final processing stages in the manufacture of electrolytic tin plate for food containers.

Mr. Sargent goes over the installation and dwells on the control devices at each of the major sections of the water treatment plant. The experience gained on this installation according to Mr. Sargent is that it is wise to select semi-automatic and semi-manual controls with sound engineering of interlocks and limit check systems. The advantages are held to be safe, smooth operation with rapid correction of irregularities, improved efficiency resulting in lowest operating cost and a minimum of maintenance expenses.

A. M. Guy, Commonwealth Associates, Inc., selected as his topic "Handling Effluent—Deaeration, Pipe and Tank Linings." He confined his remarks to effluents from monobed demineralizers. The water so handled has a total solids content of from 0.5 ppm down to 0.05 ppm or less, resistivity in the order of 1 million to 20 million ohms, and CO_2 always less than 0.05 ppm with ammonia content at zero or for all practical purposes not detectable and a pH of 6.5 to 7.5. The temperature of this water is generally between 35 F and 90 F. This water is extremely aggressive especially with respect to iron and copper. This last-named property, though, can be controlled by a pH between 8.8 and 9.2.

The only type of satisfactory container for demineralized water of this purity is stainless steel. Type 304, 18–8 stainless, has proved particularly applicable. In addition the lower the temperature of the water the better. Mr. Guy recommended a completely degassed state for the demineralized effluent with the pH corrected to the optimum iron solubility levels and then blanketed by either helium or nitrogen to prevent oxygen reabsorption. With these preparations the water could be stored indefinitely.

"The Effect of Drought Delaware River Water Conditions in Demineralizing Plant Operations" by **C. J. Sprigman,** technical dept., Socony-Vacuum Oil Co., was based upon a pressure type demineralizer of 495 gpm design capacity installed at the Paulsboro refinery of the speaker's company in 1953 and a gravity demineralizer of 1000 gpm installed in 1946.

The background information was excellent with a graph on the Delaware River's drought years shown. The difference between normal and drought years was determined by a number of studies and plots carried out by various authorities on the Delaware River over a period of years. In the ten years the gravity demineralizer was in service, four years were drought years.

The first step the Paulsboro refinery did when it felt drought years were possible problem years was to find out how they could obtain the best quality of raw water during the low run-off periods. This they found was available during both normal and drought periods over the ebb tide periods. So a $2^1/_4$ million gallon storage tank was built and water pumped into it during low tide. Next they put down three wells having a total of 2900 gpm.

In addition to these steps a system of pretreatment for river water has been in effect. The speaker described this pretreatment system in detail and gave the operation details of the demineralizer on normal river water and again during drought periods. An indication of the effect of drought conditions can be seen from the change in total dissolved solids from 150 ppm for normal river water to 900 ppm during droughts.

D. C. Carmichael, senior power engineer, E. I. du Pont de Nemours and Co. Inc., explained the "Factors Influencing the Design of Interface Grids for Mixed-Bed Demineralizers." All the grids must fulfill certain basic requirements. They must collect and distribute the liquid at closely spaced points over the cross-section of a demineralizer bed so no parts are incompletely regenerated or reused and no ion-exchange particles can escape. Further, the grids must be of corrosion-resistant materials to withstand the regenerant chemicals.

Water Corrosion

"Water Corrosion of Structural Materials" by **A. H. Roebuck,** Continental Oil Co., was developed from data arising out of experiments with which the speaker had been associated while with the Argonne National Laboratory.

The experiments were prompted by a need for knowledge in (1) the specification of metals for use in reactor assemblies utilizing water and (2) the study and development of alloy systems which will exhibit high corrosion resistance in such media. Failures in reaction systems from faulty materials cannot be tolerated.

Studies of stainless steels and other metals under high temperature water conditions have been well started. But much work needs to be done on metals, such as plain carbon steels, and on other alloy systems.

Irradiation can cause the dissociation of water into its component gases. In reactors this factor of irradiation varies from point to point so that the dissolved oxygen and hydrogen concentrations can vary within the system and be of an entirely different nature from dissolved oxygen in conventional boilers. The extent of removal of this oxygen in reactors by chemicals is limited because of undesirable side reactions. So the problems arising from a continual source of oxygen need evaluating and eventual solution.

The speaker furnished a tabulation of the corrosion resistance of various metals and classes of metals in high purity water at several temperatures. He further supplied correlative information on several of the more important variables and reviewed the general corrosion characteristics of the metals studied. Among the points covered were temperature, effects of water purity and chemical additions, effect of dissolved gases, velocity, pressure and stress.

Discussion

D. J. DePaul, Westinghouse Electric Corp., brought up the point that one of the most important corrosion problems associated with materials in contact with water is crevice corrosion. It has proved to be a major concern in the choice of materials for water-cooled reactor components.

Crevice corrosion, as Mr. DePaul described it, is the production of relatively large amounts of corrosion product at the mouth of a crevice which, in applications involving moving parts with small clearances, may cause excessive wear or complete seizure. The mechanism of attack is an oxygen concentration cell. A table was supplied to give the general picture of material susceptibility to corrosion crevice problems.

In addition to the problems of corrosion buildup Mr. DePaul mentioned that corrosion crevice pitting can be equally difficult to overcome.

C. R. Breden, Argonne National Laboratory, confined his comments to the Roebuck paper. He began by stressing the theory of dissociation and the change in emphasis it puts on design elements. The concern over corrosion rate differences that might appear trivial for the materials under consideration to the conventional boiler designer is an illustration of their difference in emphasis.

Mr. Breden then discussed the reaction of other experimenters to certain of the important variables Dr. Roebuck covered. Among these were the effect of pH and the nature of metal attack under high temperatures.

R. F. Koenig, Knolls Atomic Power Laboratory, mentioned that in the time since the speaker completed his work at Argonne, intensified corrosion testing has continued. The major concern in the nuclear power field is the small amount of corrosion products that tend to deposit on heat transfer surfaces to impede flow of heat and to become radioactive. Once radioactive they may be swept along and show up in the primary coolant system. So the emphasis is on reducing the amount of these products and developing procedures for removing them from the operating system. Mr. Koenig listed several materials that were under test at the moment.

Cooling Water Systems

H. Lewis Kahler and **Charles George,** W. H. & L. D. Betz Co., collaborated on the paper "A New Approach in Corrosion Prevention in Cooling Water Systems." In an earlier paper presented to the 11th Water Conference the deficiencies of many corrosion inhibitors in use, particularly from the standpoint of controlling pitting and tuberculation, were summarized. As a result of studies on corrosion and pitting the Dianodic method of control was advanced.

Now laboratory and plant performances show that zinc can be a versatile and effective material for improving the control of pitting and corrosion in cooling water systems. Whether the zinc is used in the soluble or coating range depends on the individual conditions. To be successful, zinc must be used with chromate and phosphate since zinc alone possesses little power for corrosion inhibition. Satisfactory results develop with zinc concentration over the range of 0.8 to 10.0 ppm as Zn.

Discussion

R. G. Wickert, Armstrong Cork Co., stated that his concern sought out the authors to help them in combatting recirculating water difficulties such as tuberculation in pump casings and piping, plus heavy scaling in high temperature, low velocity sections of their heat exchangers. In 1951 the subject method of water treatment was inaugurated and results exceeded expectations. In fact Mr. Wickert stated that piping repairs in their mechanical oxidizing operation alone has been reduced $22,000 in three years.

The Burning of Sulfate, Soda and Sulfite Waste Liquors*

By EUGENE H. KENNEDY

Paper Mill Engineering Department, Combustion Engineering, Inc.

The author has included a brief history of waste-heat and chemical recovery units for the paper industry. The source and preparation of the fuel and methods of burning are discussed. Typical analyses of waste-liquor solids are compared and their use in the construction of combustion-characteristics curves is outlined.

SULFATE, soda and sulfite waste liquors are the residual liquors left after wood or other cellulose-bearing material has been digested with certain chemical solutions and the cellulose fibers separated therefrom. In general, it may be said that sulfate waste liquor remains after digestion with sodium hydroxide and sodium sulfide. Soda waste liquor remains after digestion with sodium hydroxide. Sulfite waste liquor remains after the digestion with calcium, ammonium, sodium or magnesium bisulfite solutions. The waste liquor contains these inorganic chemicals alone and combined with the lignins and resins of the wood which bound the cellulose fibers together. It also contains sugars and organic acids. In the furnace the organic carbonaceous material is burned and the inorganic chemicals are smelted and recovered.

The capacity of a recovery unit is spoken of as so many tons per day, meaning that it will burn and smelt the waste liquor from the making of this many tons of pulp per day.

Historical

Four basic processes are used for the production of pulp: sulfate, soda, sulfite and neutral sulfite semi-chemical. The sulfite process is the oldest, dating back to 1867, when calcium bisulfite cooking liquor was first used. The soda process was introduced in 1880, and the sulfate process in 1907. Many people helped in the development of methods of burning these waste liquors both here and abroad. In this country, Waern, Cary, Goodell, Wagner, Moore, Greenewalt and Tomlinson pioneered much of the earlier work in burning sulfate and soda-waste liquor.

The earlier soda units prior to about 1930, were reverberatory furnaces and brick-lined rotary furnaces. In the former, the black liquor from the digesters was thickened in evaporator passes by hot gas from an auxiliary fuel. The solids left behind in the form of ash and clinker were raked from the furnace and transported to leaching tanks, where the recovered chemicals were dissolved in water.

The brick-lined rotary furnace was a later development. Here previously evaporated black liquor was fed into the gas-outlet end of the rotary and tumbled around in the furnace until the greater portion of the water was evaporated and a black ash was formed. The hot gas for evaporating the water was supplied from a separately fired furnace or from a smelter furnace into which the black ash fell and was burned.

During this earlier period, little attention was paid to the generation of steam from the waste gas and some of the units did not have a waste-heat boiler. Later, a waste-heat boiler was added after the rotary and also a disk or cascade type of evaporator for the purpose of further concentrating the waste liquor before burning. Even before the advent of the larger spray-type furnaces, the waste-heat and chemical-recovery unit in the pulp mill had become important and reliable enough to be tied into the main steam header to augment the steam produced by other fuels in other steam-generating units.

* Adapted from a paper presented on September 8 at the Fall Meeting of The American Society of Mechanical Engineers held in Milwaukee, Wis.

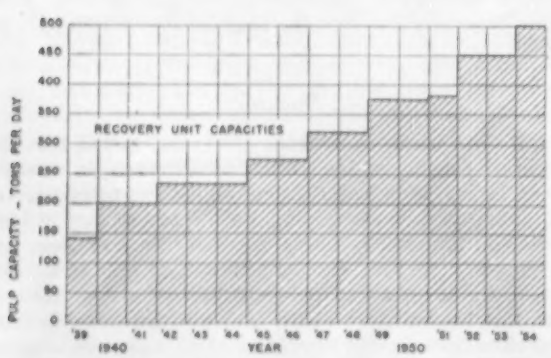


Fig. 1—Design trend in recovery-unit capacities

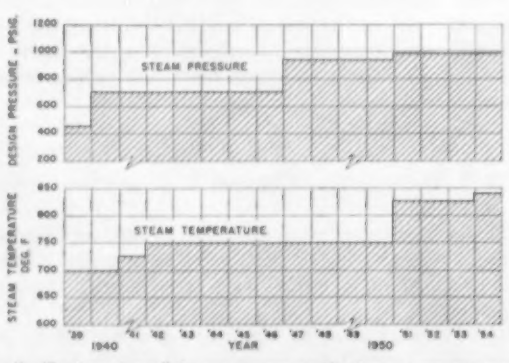


Fig. 2—Design trend in recovery-unit steam pressure and temperature

Trend in Design of Recovery Units

The trend in capacity, steam pressures and steam temperatures† in recovery units has followed that of other steam-generating units here in this country. Capacities of the early rotary-kiln type recovery units were in the neighborhood of 40 or 50 tons of pulp per day and later increased to 75 to 80 tons per day. This later figure was soon found to be about the highest capacity attainable with this type of unit because of the physical limit of capacity of the rotary kiln itself without its becoming enormously cumbersome. Introduction of the spray principle to the burning of waste sulfate liquor in the early 1930's opened up the possibility for the rapid increase in recovery-unit capacity. Beginning at 100 to 150 tons per day capacity in the late 1930's, capacities have now reached 350 to 400 tons per day in a single recovery unit and capacities of 450 to 500 tons per day in a single recovery unit are now being designed. Fig. 1 shows the trend in recovery-unit capacities.

The trend in design steam pressure also has been upward beginning at 400 psig in the mid-thirties and approaching 1000 psig at present. The trend in steam pressure is shown in Fig. 2. Steam temperatures on the early spray-type units began at about 700 F and have risen to 840 F in the most recent units, as shown in Fig. 2.

With the increase in steam temperatures, a change in the physical design of the superheater also has taken place. From the standard type vertically hung superheater elements placed on fairly close spacing, six inches from center to center, the trend is now toward vertically hung platens having tangent tubes from front to rear and transversely spaced from sidewall to sidewall on fairly wide spacing. Transverse spacing of platens on the first units were 12 in. but should it be desirable, this spacing may be increased to 15 or 20 in. Platen-type superheater elements on wide spacing will eliminate serious fouling and plugging with slag in the superheater zone to such an extent that they may be kept clean with retractable soot blowers and hand-lancing will be unnecessary. Fig. 3 shows an installation of a platen-type superheater in recovery unit.

A radical change has taken place in the physical design of the smelter pot or hearth upon which the black ash from the waste liquors is actually burned and smelted. It is a far cry from the old thick, concrete walled, soapstone-lined smelter pot with its water-cooled primary-air blow pipes of the earliest recovery units to the furnace hearth of today's modern ones. Repair of the refractory hearth has always been one of the major maintenance items of the recovery unit. This is true today, with the exception of the very latest units. In them, the thick layer of refractory chrome brick over the floor tubes has been replaced with a thin layer of plastic-chrome refractory. Expansion and contraction problems of the thick refractory bottom are minimized greatly and the decanting type of furnace bottom with its raised smelter spout promises to be the answer to many design and maintenance problems of the past. With the decanting type of furnace bottom, the lower layer of smelt just above the plastic chrome is frozen so that there is no mechanical wear or erosion of the smelt flowing directly over a plastic-chrome or a chrome-brick surface. A bottom of this type has been in service now for 15 months on a 350-ton unit, without any trouble or maintenance.

Fig. 3—Installation of platen-type superheater in a recovery unit

There seems to have been a moderate reversal recently in the means and methods of soot blowing for cleaning the heat-absorbing surfaces of a recovery unit. In the first spray-type units, no soot blowers were supplied for the front bank and superheater zone. The boiler and economizer passes were cleaned by means of hand-operated soot blowers using steam as a cleaning medium. Later units used retractable soot-blower elements in the front bank and superheater zone using steam as a cleaning medium and sequentially and automatically operated soot blowers in the boiler and economizer passes using compressed air as a cleaning medium. Recent units are being supplied with more soot blowers using steam as a cleaning medium. Such recent units are now being cleaned with steam in the front bank and superheater zones and in the first boiler pass, the last boiler pass and economizer pass being cleaned with steam or compressed air. In any case, all of the soot blowers on modern recovery units are automatically sequentially operated by the operator.

Source and Amount of Fuel

The following figures show pulp production in the United States for 1952:

	Tons per Year	Per Cent†
Sulfate pulp (paper grades and alpha*)	8,927,131	74.2
Sulfite pulp (paper grades and alpha*)	2,701,803	22.5
Soda pulp	425,000	3.3
Totals	12,053,934	100.0

† "New Developments in Recovery Unit Design," by F. W. Hochmuth, *Tappi*, Vol. 36, No. 8, Aug. 1953, pp. 359–366.

* Assumed that half the dissolving and alpha pulp was made by the sulfate process and half by the sulfite process.
† "The Southern Pulp and Paper Manufacturer," Oct. 1, 1953, p. 213.

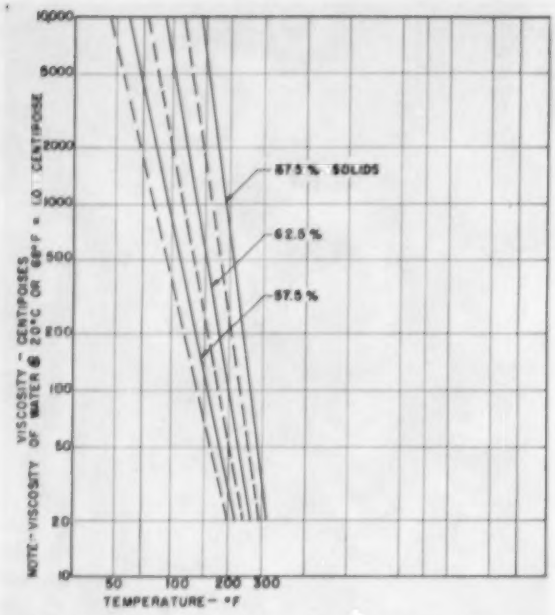


Fig. 4—Absolute viscosity of sulfate waste liquor

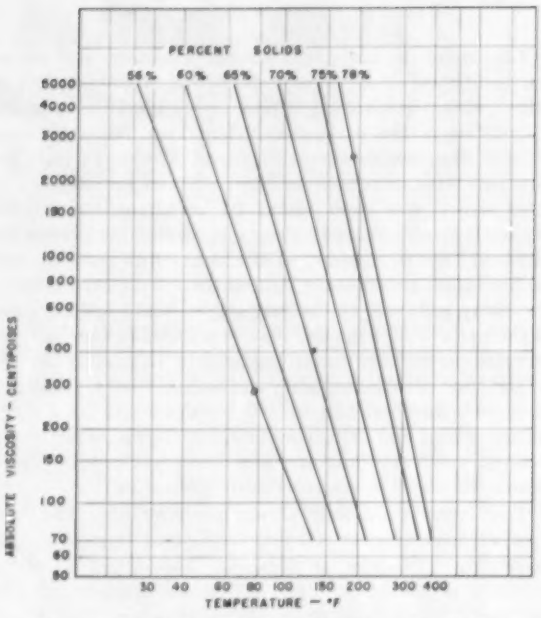


Fig. 5—Absolute viscosity of soda waste liquor

Most of the sulfate pulp is made in the Southern and Southeastern States, and they account for about 82 per cent of the production. The Pacific Northwest accounts for most of the remaining sulfate-pulp production, amounting to about 11 per cent.

Sulfite-pulp production is scattered through the New England, Middle Atlantic, Lake, Pacific and Southern States with the Pacific States leading and the Lake States in second place with 42 and 26 per cent, respectively.

Soda-pulp production also is scattered among the same group of states with the Middle Atlantic States ahead with 39 per cent and New England States second with 29 per cent of the production.

Although at the present time, the sulfate and the soda processes furnish practically all of the waste liquor which is burned, there is still a sizable amount which potentially can be furnished by the sulfite process.

If we assume 340 operating days per year, and 3000 lb of dry solids available per ton of pulp produced by the sulfate and soda processes, and that $3^1/_2$ lb of high-pressure, high-temperature steam can be generated per lb of dry solids, then we arrive at the following significant figures for the combined sulfate and soda processes:

Dry solids available, tons per day	41,250
High-pressure steam-generated, tons per day	137,500

Since the heating value of a pound of dry solids is only half that of coal and the steam-generating efficiency is only two-thirds that of coal, we find that the dry solids is equal to about $^1/_3$ of the same amount of coal as a source of fuel; or

Equivalent coal replaced, tons per day	13,750

These figures are for the United States alone, but there are large amounts of sulfate waste liquor burned in Canada and the Scandinavian countries.

Although only a very small percentage of the sulfite-waste liquor produced is burned today, there is as stated before, a potentially sizable amount available. If we assume, 2200 lb of dry solids available per ton of sulfite pulp and 5 lb of high-pressure, high-temperature steam generated per lb of dry solids, then we obtain a similar set of figures for the sulfite process:

Dry solids available, tons per day	8,800
High-pressure steam, tons per day	44,000
Equivalent coal replaced, tons per day	4,400

Preparation of Fuel

Waste liquor from the sulfate, soda and sulfite pulping processes must be prepared outside of the recovery unit proper before it can be successfully burned. This preparation or preprocessing consists in the separation of the waste liquor from the pulp or cellulose fiber and then the separation of water from the waste liquor solids. This preprocessing begins with the pulp washers where as great a percentage of the waste liquor is recovered as is possible with a minimum of dilution. This is accomplished by three-stage countercurrent washing recovering about 95 per cent of the total solids; and the weak waste liquor, commonly called black liquor in the sulfate and soda process, is recovered at a concentration of about 16 per cent solids and 84 per cent water.

The next step is the removal of water from the black-liquor solids in multiple-effect evaporators consisting of quadruple or quintuple stages. From 4 to $4^1/_2$ lb of water can be evaporated per lb of steam used, depending on the number of stages. The concentration of sulfate and soda-waste liquor is almost universally done in standard long-tube, indirect-heat-exchange type evaporators. Recently, the multiple-effect, switching, plate-type evaporator developed by Rosenblad in Sweden has come into use in this country for the evaporation of calcium-base sulfite waste liquor in order to take care of the calcium deposits which are encountered.

The thermal-compression-type evaporator is now being given more attention for the concentration of both sulfite and sulfate waste liquors. Already a unit of this type is being operated successfully in Canada, concentrating the waste sulfite liquor from 12 to 52 per cent solids from 40 tons of calcium-base sulfite pulp per day. A Scandinavian pulp and paper manufacturer is now considering the use of this type of evaporator for concentrating the sulfate waste liquor from 400 tons of pulp per day. The initial cost of the thermal-compression-type evaporator may be a little higher than the standard type but the thermal efficiency is about three times as great, it being possible to evaporate 13 to 14 lb of water with one lb of steam or its equivalent.

In any case, the multiple-effect evaporator concentrates the waste liquor to from 50 to 55 per cent solids before it reaches the recovery unit proper. As an integral part of a sulfate- or soda-recovery unit, a direct gas-contact type of evaporator, such as the cascade evaporator or cyclone evaporator using hot flue gas from the recovery boiler, further concentrates the waste liquor to from 60 to 80 per cent solids before it is introduced into the furnace and burned.

Methods of Burning the Fuel

As waste liquor is concentrated from 16 to 80 per cent solids, it gradually becomes more viscous. After reaching concentrations above 50 per cent solids it must be heated above room temperature in order to reduce its viscosity sufficiently for pumping and spraying into the furnace. Waste liquor coming from the multiple-effect evaporators at 190 to 200 F is usually hot enough for pumping 50 to 55 per cent solids liquor. However, after being concentrated further in the gas-contact evaporator, it must be heated enough to give a viscosity of about 250 centipoises for pumping and 125 centipoises for spraying. The temperatures may vary slightly depending on the kind of waste liquor and the per cent solids to which it has been concentrated.

Typical viscosity curves of sulfate, soda, calcium sulfite and neutral sulfite semi-chemical waste liquor showing its variation with per cent solids and temperature are shown in Figs. 4, 5, 6 and 7, respectively. In Fig. 7 the viscosity of neutral sulfite semi-chemical waste liquor containing 57 per cent solids is plotted against temperature with varying spindle speeds of the Brookfield viscometer. These curves indicate that this waste liquor possesses thixotropic viscosity characteristics; that is, the viscosity for a given temperature tends to fall off with increased rate of shear or increased spindle speeds. Other waste liquors exhibit this same type of viscosity.

After sulfate and soda waste liquor is concentrated to the proper per cent solids content and heated to give the proper viscosity, it is sprayed, into the recovery furnace for burning by one of two general methods. Either the concentrated waste liquor is sprayed or "painted" onto the walls of the furnace or it is sprayed into the furnace without touching the walls. Even in a concentrated state, waste liquor is still a relatively "wet" fuel containing from 20 to 40 per cent water. It must therefore be allowed to release a good portion of its moisture content before the residual black ash reaches the hearth where combustion and smelting are completed. In the first method mentioned above, concentrated waste liquor of about 60 per cent solids is sprayed onto the lower furnace walls, where successive layers give up most of their moisture and then fall off in relatively large pieces down onto the hearth, mostly around the periphery of the hearth. Fig. 8 shows a

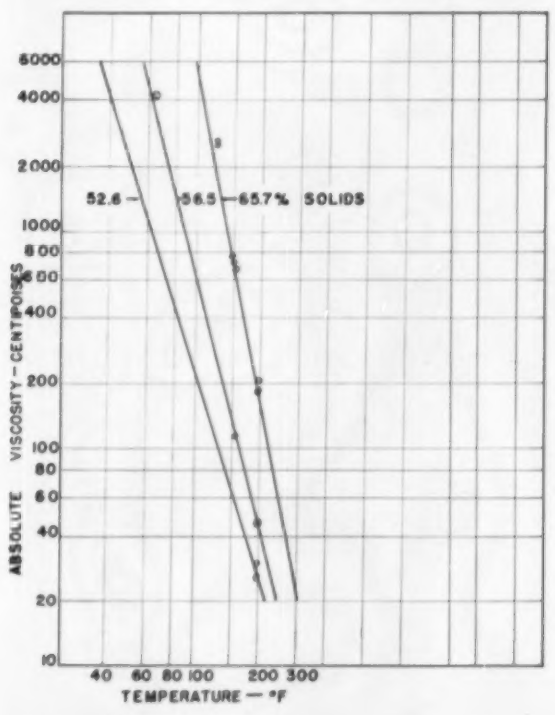


Fig. 6—Absolute viscosity of calcium sulfite waste liquor

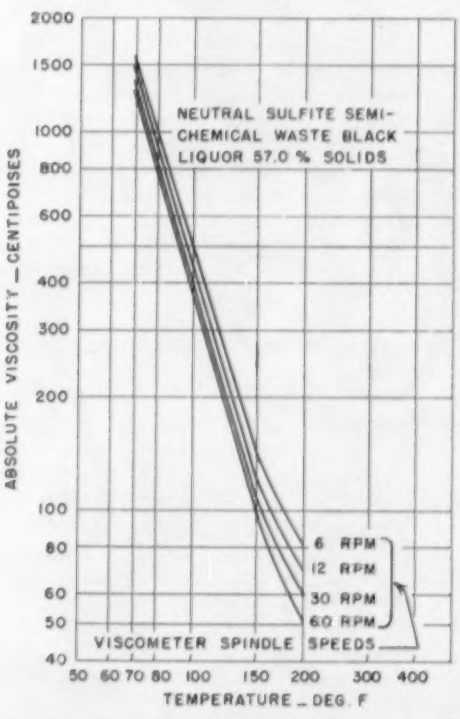


Fig. 7—Absolute viscosity of neutral sulfite semi-chemical waste liquor

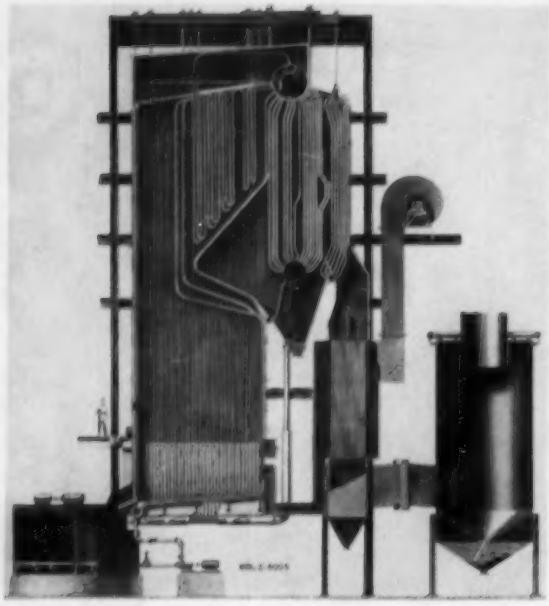


Fig. 8—Typical B. & W. recovery unit

typical B. & W. recovery unit using this spraying method.

In the second method, concentrated waste liquor of from 65 to 70 per cent solids, in the case of sulfate liquor, and from 75 to 80 per cent solids in the case of soda liquor is sprayed directly into the furnace. Most of the moisture is flashed from the coarse spray, and the remaining black-ash particles fall onto the hearth forming roughly a truncated conical pile. Fig. 9 shows a typical Combustion Engineering recovery unit using this method of spraying.

In either method, combustion and smelting are completed by admitting preheated primary air through multiple ports around the periphery of the lower furnace two or three feet above the hearth. Preheated secondary air is admitted through multiple air ports located in the furnace walls above the primary-air ports in order to burn off the volatile gas.

Roughly speaking, when burning sulfate waste liquor, from 60 to 65 per cent of the total air is admitted through the primary air ports and from 35 to 40 per cent through the secondary air ports. Sulfate waste liquor must be burned with very little excess air in the furnace, probably not over 10 per cent excess air, because it is desired to reduce 95 per cent of the sodium sulfate present or formed to sodium sulfide. Excess air leaving the economizer will run about 15 per cent.

When burning soda-process waste liquor, a slightly higher excess air is permissible because no sodium sulfate is present to be reduced. The per cent excess air leaving the economizer will run about 20 per cent. Most of the total air through the air ports of a soda-process recovery unit is admitted through the primary air ports and may be as high as 80 to 85 per cent, the balance being admitted through the secondary air ports.

Relatively speaking, not very much sulfite waste liquor has been burned in this country. Sulfite pulp can be made from either calcium, magnesium, ammonium, or sodium bisulfite cooking liquor and the greatest amount is made from the calcium base. As long as the weak waste sulfite liquor could be run into a body of water and disposed of in this manner, it was done. But recently, state and federal boards of health have become more strict about stream pollution, especially in the states bordering on the Great Lakes. It was not until the invention and development of the Rosenblad switching type of evaporator for calcium-base sulfite waste liquor five or six years ago in Sweden, that it was practically possible to concentrate this sulfite liquor. Even then, because of the relatively low cost of lime, sulfur and other fuels such as coal or oil, it was not economically feasible to burn this sulfite liquor in this country.

The multiple-effect evaporator must be made of stainless steel and is therefore costly and the practical limit of concentration seems to be about 53 per cent solids, unless a concentrator effect is used. Most of the calcium-base sulfite-liquor burning in this country has been done at several of the paper mills in the Wisconsin area under the auspices of the Sulphite Manufacturers Research League, where it has been carried out on a full plant-size scale but only for short periods. This waste liquor is burned in suspension like fuel oil by first being heated and then atomized in steam or mechanical guns. The ash content of this waste-liquor solids is only about one-fourth that of sulfate or soda liquor solids and its melting point is about 2500 F compared to 1500 F for sulfate or soda ash. Calcium-base liquor is being burned at one plant in Wisconsin in conjunction with pulverized coal as an auxiliary fuel in a completely water-cooled furnace. If no auxiliary fuel is used, it must be burned in a refractory or partially water-cooled furnace. Another plant in Wisconsin area is burning it in such a refractory furnace of the cyclone type, similar to one pioneered and developed in Sweden by Rosenblad. In neither of these cases is the calcium or sulfur recovered.

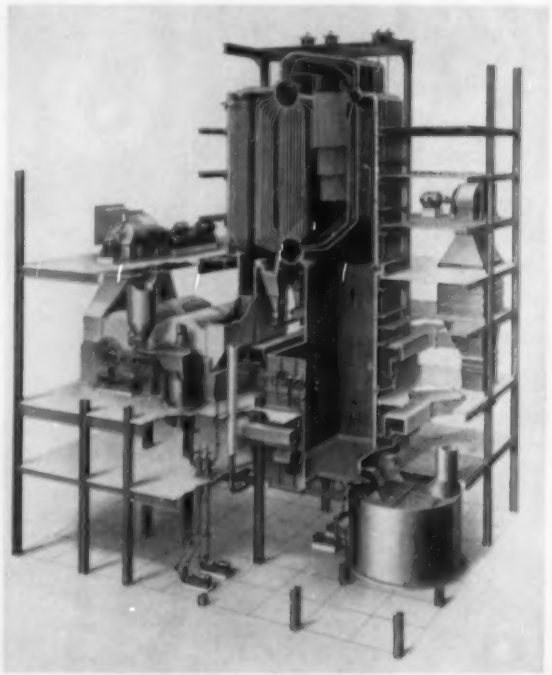


Fig. 9—Typical C-E recovery unit

Magnesium-base bisulfite liquor is being burned continuously on a large plant-sized scale at one plant in the Northwest and a similar plant is now operating in Alaska. At both of these plants, the magnesium base is recovered as the oxide and the sulfur as sulfur dioxide.

Another large pulp mill in the Northwest is burning ammonium-base bisulfite liquor in a refractory furnace but is not recovering either the base or the sulfur. No steam is generated since all of the heat resulting from the burning of the waste liquor is used for concentrating the waste liquor from 15 to 45 per cent solids.

There is one pulp mill in Finland making about 200 tons per day of dissolving pulp by the sodium-base bisulfite process which has been operating over a year now. It is using the Sivola process of cooking and chemical recovery. Both the sodium base and the sulfur are recovered and, of course, steam is generated in the recovery unit.

Analysis of the Fuel

In the design of any equipment generating steam from the burning of a combustible material, it is necessary to know the analysis of the fuel. From its analysis, the quantity of air needed and the quantity and character of the gaseous product evolved can be calculated. The calorific value of the dry solids also must be known in order to calculate the total heat input. Knowing these values, furnace, superheater, boiler, economizer, and cascade-evaporator surfaces may be specified and gas and air temperature at various points throughout the unit can be calculated. Later, a heat balance can be made, and the amount of steam which can be generated from a given quantity of fuel can be estimated closely.

Since the fuel contains a relatively large amount of water, one of the first steps in its analysis is an accurate determination of the moisture present. Several methods are used to determine moisture content or in other words, total solids in waste liquors.

Those most widely used are briefly as follows:

1. Evaporating the water from a sample until it is dry in an oven at 220 F at atmospheric pressure, which usually takes from 20 to 24 hr.

2. Distilling a sample in an apparatus at atmospheric pressure using a reflux condenser and a distillate trap with an immiscible solvent or solution such as toluol, xylol or varsol which usually takes about two hours.

3. Evaporating the water from a sample until it is dry under vacuum at considerably less than atmospheric pressure and at a correspondingly lower temperature, heating the sample in a hot-water bath which will usually take from two to three hours.

4. Evaporating the water from a sample until it is dry by means of infrared lamps, the sample and dried solids being weighed in a special Cenco moisture balance which usually requires from one to one and one-half hours.

5. Determining the water in the sample directly by the Karl Fischer titration method which lately has been suggested by TAPPI under its Suggested Testing Method No. T 641 sm-54.

Next, an ultimate analysis is necessary to determine the amount and character of the combustible and noncombustible material; or, to look at it in another way, to determine what part and how much of the fuel will appear in the gaseous products and how much in the smelt or molten ash. The dried waste-liquor solids is made up of the excess inorganic cooking chemicals along with the organic material dissolved from the wood chips chemically combined with the balance of the inorganic chemicals. The organic part of waste sulfate-liquor solids is chemically described as the sodium salt of lignin-sulfonic acid in which sulfur and sodium are combined organically.

Still speaking of sulfate waste-liquor solids, an ultimate analysis should show, as they occur in the waste liquor before ignition or burning, the items and an average value for each as indicated in Table I.

TABLE I—ULTIMATE ANALYSIS OF DRY SULFATE WASTE-LIQUOR SOLIDS

			Per Cent
1	Organically combined carbon	(C)	41.70
2	Organically combined hydrogen	(H)	3.99
3	Organically combined sulfur	(S)	1.52
4	Organically combined sodium	(Na)	11.54
5	Organically combined oxygen and nitrogen	(by difference) (O + N)	27.04
	Inorganic		
6	Sodium hydroxide	(NaOH)	1.65
7	Sodium sulfide	(Na_2S)	1.74
8	Sodium sulfate	(Na_2SO_4)	2.91
9	Sodium carbonate	(Na_2CO_3)	7.91
10	Total		100.00
11	High heat value, Btu per lb dry solids		6914

Burning and Smelting

Before using the ultimate analysis to calculate combustion-characteristic curves for this fuel, something must be known about what happens when it is burned and smelted in the recovery furnace. This may be best understood by having run a sodium-sulfur balance on a typical sulfate-recovery unit. Such a balance sheet is shown in Fig. 10. From this it is learned that about $^1/_3$ of the organically combined sulfur burned to form sulfur dioxide (SO_2) and that about 75 per cent of the total sulfur entering the furnace appears in the smelt as sodium sulfide. It is further assumed that the balance of the organic sulfur combines with some of the organic sodium to form sodium sulfate and that the balance of the organic sodium combines with carbon dioxide to form sodium carbonate.

Now having this fairly accurate picture of what happens during combustion and knowing how much

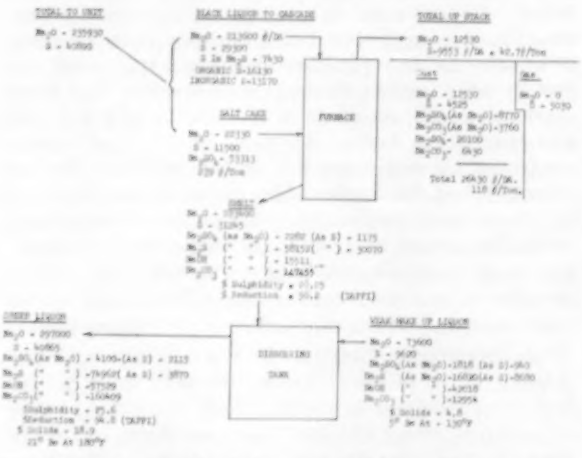


Fig. 10—Sodium-sulfur balance on 225-ton sulfate-recovery unit

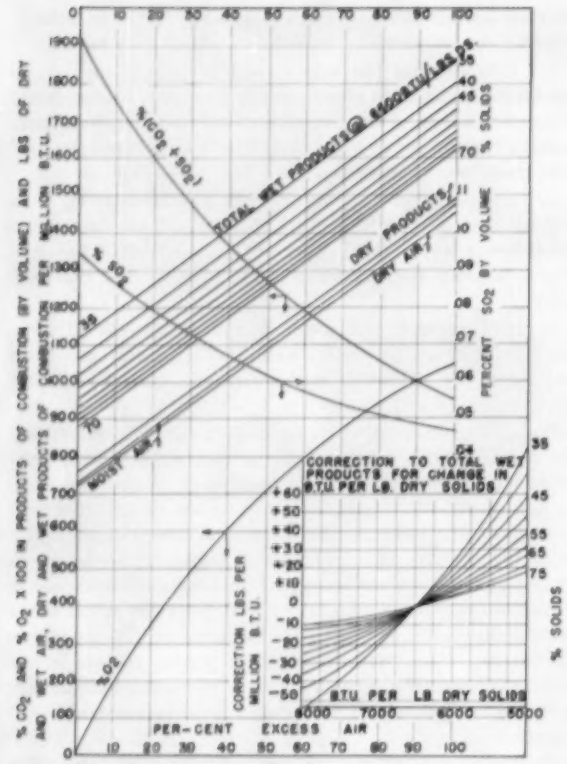

PERCENT EXCESS AIR
% SOLIDS
PERCENT SO2 BY VOLUME
CORRECTION TO TOTAL WET PRODUCTS FOR CHANGE IN B.T.U. PER LB. DRY SOLIDS
CORRECTION LBS. PER MILLION B.T.U.
B.T.U. PER LB. DRY SOLIDS
8000 7000 6000 5000
MOIST AIR
DRY AIR
DRY PRODUCTS
TOTAL WET PRODUCTS @ 4500 B.T.U./LB. D.S.

Fig. 11—Combustion characteristics of sulfate black-liquor solids

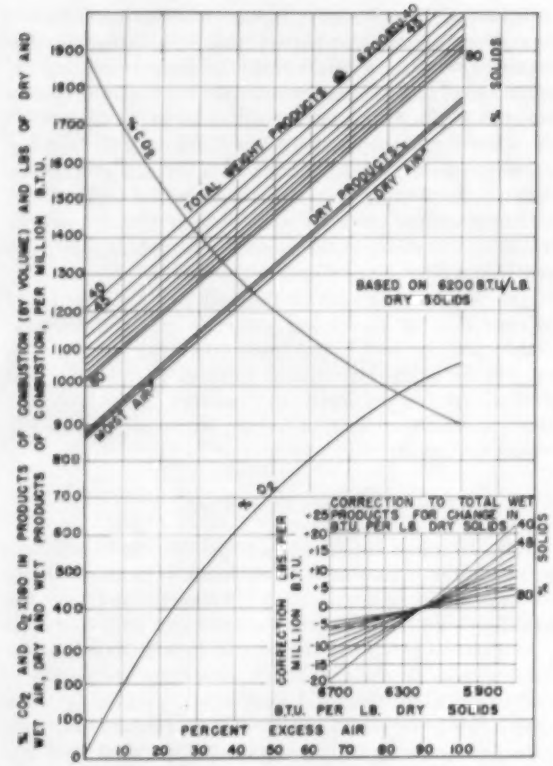

BASED ON 6200 B.T.U./LB. DRY SOLIDS
PERCENT EXCESS AIR
% SOLIDS
CORRECTION TO TOTAL WET PRODUCTS FOR CHANGE IN B.T.U. PER LB. DRY SOLIDS
CORRECTION LBS. PER MILLION B.T.U.
B.T.U. PER LB. DRY SOLIDS
6700 6300 5900
MOIST AIR
DRY AIR
DRY PRODUCTS
TOTAL WET PRODUCTS @ 4200 B.T.U./LB. D.S.

Fig. 13—Combustion characteristics of soda black-liquor solids

make-up salt cake (Na_2SO_4) is to be added, the following items can be found on the basis of 1 lb of dry solids:

1. Balance of oxygen available for combustion.
2. Balance of carbon available for combustion.
3. Amount of ash in the smelt.
4. Amount of sodium sulfate reduced.
5. Amount of oxygen supplied from the reduced sodium sulfate.

The combustion characteristics of the sulfate waste-liquor solids can now be calculated and plotted as shown in Fig. 11. Wet and dry, gas and air weights can be read directly from these curves as well as the approximate composition of the dry gas in terms of per cent oxygen and carbon dioxide for varying amounts of excess air. These gas compositions are only theoretically accurate if and when complete combustion takes place, which unfortunately, does not happen in the furnace of a recovery unit. Some carbon is unburned and some carbon monoxide is formed.

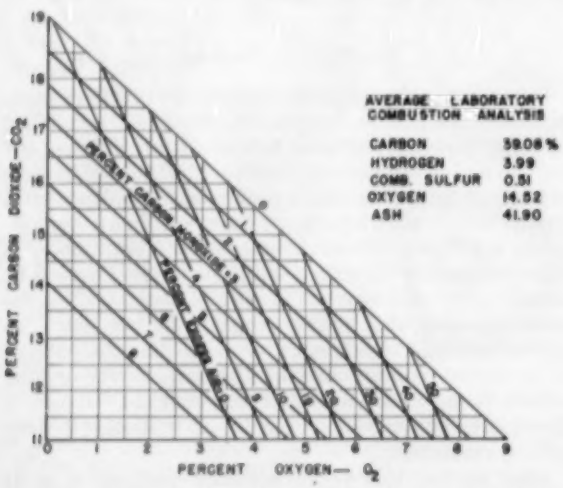


Fig. 12—Ostwald chart for sulfate black-liquor solids

Gas analysis of the products of waste sulfate-liquor solids by the ordinary orsat apparatus is difficult because combustion is incomplete and compounds are formed which the ordinary orsat apparatus does not detect. Recent tests on a large sulfate-recovery unit which had an oxygen and combustibles meter installed to sample the flue gas have illustrated this point, especially when running at above normal rating. At these overload ratings, excess air is very low and oxygen content may be as low as 0.5 per cent. Ordinary orsat apparatus showed from 2.5 to 3.0 per cent carbon monoxide but the combustibles meter showed from 6.0 to 7.0 per cent combustible. When an ordinary orsat apparatus is used to analyze the flue gases from burning waste sulfate-liquor solids, the per cent carbon dioxide, oxygen and carbon monoxide should all be determined to find whether sufficient air is being used.

Innumerable combinations of results are possible depending on the per cent of excess air being used and the ratio of primary air to secondary air. A different type of combustion-characteristic curve or chart, called the Ostwald chart, is helpful to the analyst as a check on the freshness or effectiveness of the orsat solutions, and

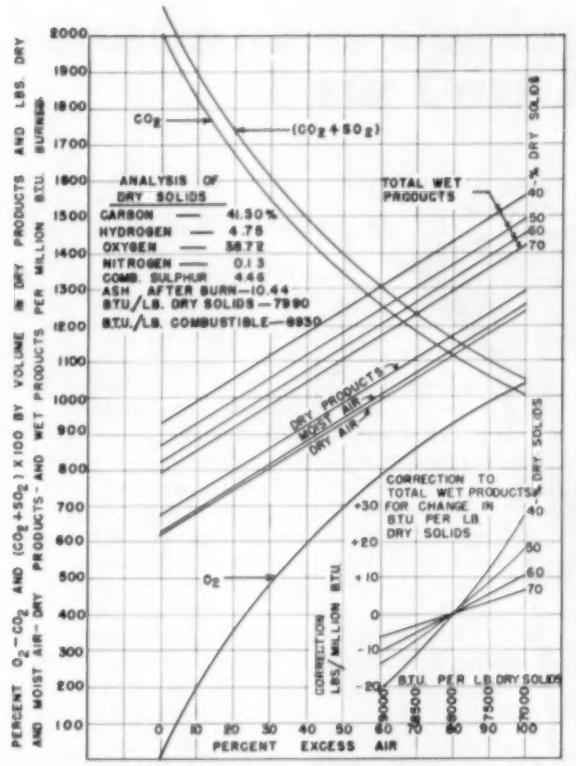

PERCENT $O_2 - CO_2$ AND $(CO_2+SO_2) \times 100$ BY VOLUME IN DRY PRODUCTS AND LBS. DRY AND MOIST AIR - DRY PRODUCTS - AND WET PRODUCTS PER MILLION BTU. BURNED
CO_2
(CO_2+SO_2)
ANALYSIS OF DRY SOLIDS
CARBON — 41.30%
HYDROGEN — 4.75
OXYGEN — 38.72
NITROGEN — 0.13
COMB. SULPHUR 4.46
ASH AFTER BURN—10.44
BTU./LB. DRY SOLIDS—7990
BTU./LB. COMBUSTIBLE—8930
TOTAL WET PRODUCTS
% DRY SOLIDS
DRY PRODUCTS
MOIST AIR
DRY AIR
O_2
CORRECTION TO TOTAL WET PRODUCTS FOR CHANGE IN BTU PER LB DRY SOLIDS
CORRECTION LBS/MILLION BTU
BTU PER LB DRY SOLIDS
PERCENT EXCESS AIR

Fig. 14—Combustion characteristics of calcium-base-bisulfite black-liquor solids

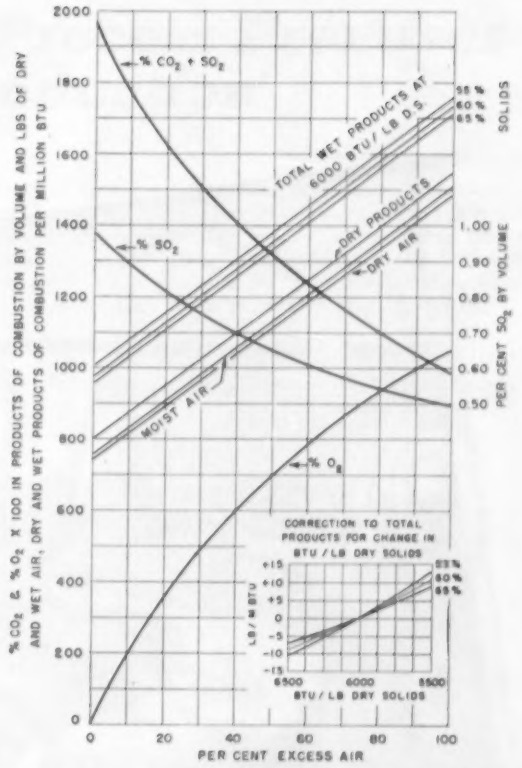

% CO_2 & % O_2 X 100 IN PRODUCTS OF COMBUSTION BY VOLUME AND LBS OF DRY AND WET AIR, DRY AND WET PRODUCTS OF COMBUSTION PER MILLION BTU
% CO_2 + SO_2
% SO_2
% O_2
TOTAL WET PRODUCTS AT 6000 BTU / LB D.S.
DRY PRODUCTS
DRY AIR
MOIST AIR
% DRY SOLIDS
PER CENT SO_2 BY VOLUME
CORRECTION TO TOTAL PRODUCTS FOR CHANGE IN BTU / LB DRY SOLIDS
LB / M BTU
BTU / LB DRY SOLIDS
PER CENT EXCESS AIR

Fig. 15—Combustion characteristics of neutral sulfite semi-chemical black liquor solids

the correctness of the technique. This chart is shown in Fig. 12. As an example, if one found 16.5 per cent CO_2 and 2.0 per cent O_2, one should expect to find about 1.3 per cent carbon monoxide and 7.0 per cent excess air.

Similarly, if we have the ultimate analysis of soda black-liquor solids, we can construct the combustion-characteristic curves for this fuel. Such curves are shown in Fig. 13. Compared with sulfate black-liquor solids, this fuel is characterized by the absence of sulfur and sulfur compounds. No sodium sulfate is formed and consequently none has to be reduced. The ash or smelt from soda black-liquor solids is nearly all sodium carbonate. The fuel itself furnishes less oxygen for combustion and none is available from the reduction of sodium sulfate and so for the same per cent excess air and the same per cent solids in the fuel, more combustion air is required and more gaseous products are formed than for sulfate black-liquor solids.

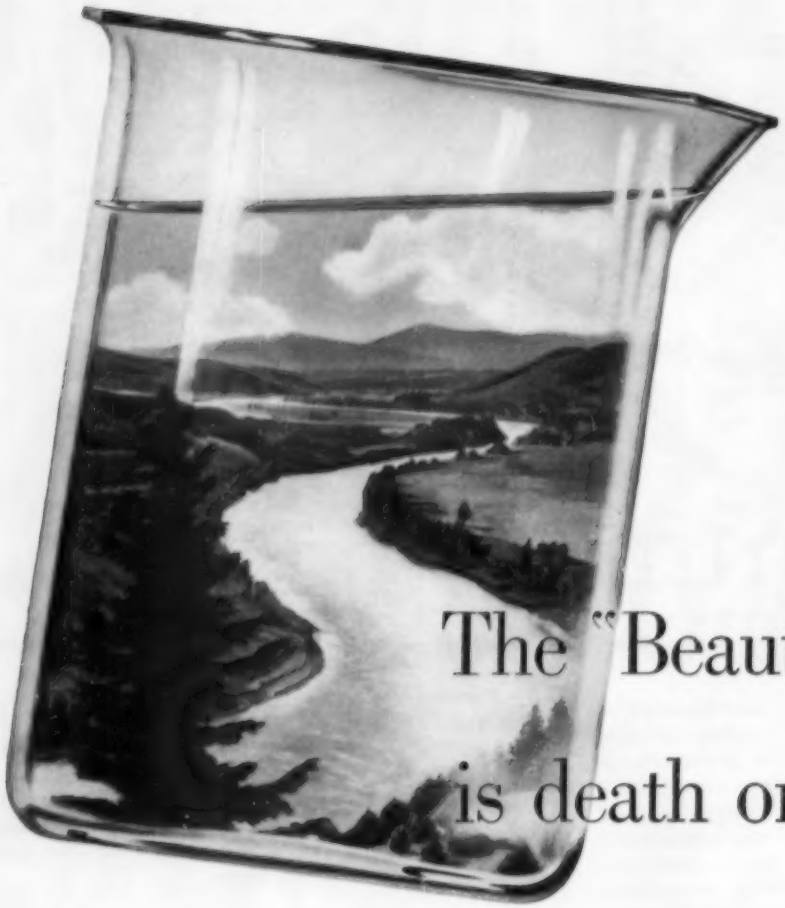
Fig. 14 shows the combustion-characteristics curves for calcium-base bisulfite waste-liquor solids. Comparatively speaking, this fuel contains more sulfur and more oxygen and has a higher heat value per pound of dry solids. Moreover, there is more organically combined sulfur present so that more SO_2 is formed than when burning sulfate waste-liquor solids. These characteristics apply to all of the sulfite waste liquors whether of calcium, sodium, ammonium or magnesium base. So much SO_2 appears in the flue gas from these sulfite fuels that it would appear to be economically feasible to scrub the waste gas to recover the sulfur dioxide.

Fig. 15 shows the combustion characteristics of neutral sulfite semi-chemical waste liquor solids. The high sulfur content is similar to the sulfite waste liquors, and laboratory tests indicate that about 55 per cent of the organically combined sulfur will burn to SO_2 and will be lost in the stack gas. On the other hand, its heating value and the amount of oxygen which it will supply for combustion is more like the solids from sulfate waste liquor. Its viscosity characteristics are quite similar to sulfate waste liquor.

Automatic Combustion Control

For the first time, as far as we are aware, automatic combustion-control equipment has recently been installed on a 350-ton sulfate-recovery unit in the Northwest. Total air regulation has been tied in with the amount of fuel fired to the furnace as well as automatic control of the ratio of primary to secondary air. The first requisite of automatic combustion control on a recovery unit burning waste liquor is an accurate and reliable heavy black-liquor meter which will measure the amount of fuel to the furnace. We feel that such a meter has been developed and is now available. Another valuable instrument which has recently been improved and made more accurate and reliable is the oxygen and combustibles meter. This instrument is very helpful from an operating standpoint for adjusting the fuel-air ratio and also as a means for evaluating the response of the automatic combustion-control equipment.

Such is the general picture of the burning of sulfate, soda and sulfite waste liquors but much research work remains to be done on the ultimate analysis of the fuel and the waste gas in order to enable them to be burned more efficiently.



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Continuous Coking Process Promises Low Cost Production*

By DR. ING. KURT BAUM,

Essen, Germany

Restricted air admission to a horizontal layer of coal on a traveling grate stoker supports an extrothermal reaction which the author describes as "autogenetic coking." The process transforms coal to coke at 15 to 30 times the rate of coking ovens. The reaction theory and the calculations to establish the basic laws behind it are presented as well as many applications.

DRY distillation, the most generally used process of producing coke, wherein retorts or coking ovens are sealed against atmospheric air and heated from the outside, is fundamentally a high cost operation. The furnaces yield low specific outputs of from 2.1. to 2.5 lbs of coke per hr per sq ft of heated surface so that units must be large and necessarily entail a heavy investment charge. The secondary products from the process, such as gas, tar and ammonia, have been traditionally expected to reduce these high costs. But in Europe, as well as elsewhere, prices for these by-products have not followed the price increase shown by coals, Table I. Increasing interest has therefore been shown for a low-cost coke-producing process.

TABLE I.—RELATIVE PRICE INCREASES: COKING COAL, COKE AND BY-PRODUCTS, 1939 AND 1953, GERMANY

Coking coal	1:3.5	Engine benzol	1:1.7	Fuel oil	1:2.1
Blast furnace coke	1:3.4	Ammonium sulfite	1:2.3	Gasoline	1:1.6
Coke oven gas	1:3.4	Tarpitch	1:2.5	Diesel fuel	1:1.5

Experiments with Autogenetic Coking

In 1938 Anderson and Renaud of the Shawinigan Chemicals, Ltd., Montreal, patented an arrangement whereby coke is produced from a thin coal layer on an ordinary traveling grate stoker within a closed furnace. This process, which can be described as autogenetic, goes back to the beehive oven, the oldest type of coking oven. The major difference is that the new method employs a traveling bottom on which the volatile matter is continually driven off.

Following an extensive development program on a semi-industrial scale a new coking process, U. S. Patent No. 2,380,930, Fig. 1, has evolved, which now delivers a 385-ton daily output at Shawinigan for calcium carbide production. The process admits only a very small amount of air from a number of subdivided compartments to the coal layer traveling through the coking furnace. By controlling this air volume the combustion of gases driven from the coal is purposely kept incomplete to release CO and H_2 inside or above the fuel bed. The reducing atmosphere so formed prevents the fixed carbon of the residual coke from reacting with free oxygen which is essentially the situation in a closed coking oven. The coke produced in this manner does not show any higher ash content than coke from the dry distillation process, yet it is produced at a coking rate that is remarkably greater.

A review of the fundamentals of fuel bed firing reveals

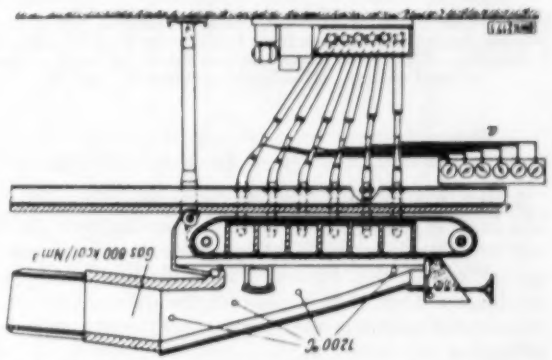


Fig. 1.—Schematic arrangement of a continuous coking stoker and its attendant air control for the autogenetic method

that coal layers with a thickness of 2 to 4 inches can be completely burned at a combustion rate of 30 to 40 lbs per sq ft per hr. The coal passes through all stages of ignition, degasification, and coking, to complete combustion of the coke. In so doing the coking phase is accomplished far more rapidly than with dry distillation.

A similar process occurs in the revolving grate gas producer operating with only half the theoretical combustion air. This limitation restricts the heat of the exothermal reaction to one third of the fuel heating value while the two thirds balance remains tied in the gas. Even under these conditions the fuel is gasified at a rate of 30 to 37 lbs per sq ft per hr. With a coking phase preceding complete gasification the producer would turn out a corresponding amount of coke if it were removed before gasification of the fixed carbon would begin.

The conditions just described hold the key to understanding of the autogenetic coking process so successfully developed by empirical means. Coal is transformed to coke at Shawinigan at the rate of 37 to 61 lbs per sq ft per hr—a tremendous improvement over the dry distillation rate of 2.1 to 2.5 lbs per sq ft per hr. This rate increase corresponds to a reduction in coking time from 16 to 20 hr down to 12 to 20 minutes.

The coke quality from the autogenetic process does not compare with that from standard blast furnaces. But for many chemical and metallurgical requirements this coke works out fine and rates as superior in some instances because of its excellent reactive capacity.

In addition, there are seueral ways of generating steam from the heat evolved, pp. 63–64.

* Brennstoff-Warme-Kraft, July 1954, pp. 244–249. Paper presented at World Power Conference, July 25–Aug. 10, 1954, Rio de Janeiro.

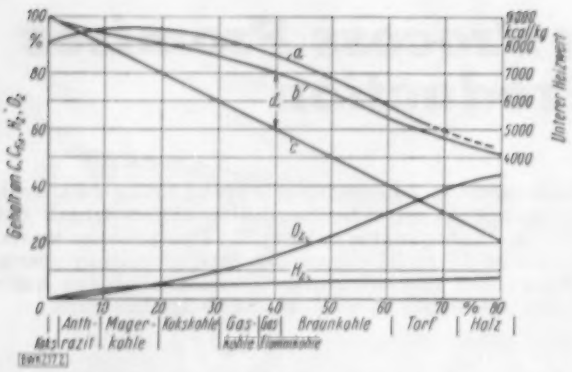


Fig. 2—Composition of solid fuels considered for coking process (moisture and ash free) from Ruhr Coal Handbook, F. Schulte. Curves (a) lower heating value, (b) total carbon, (c) fixed carbon, (d) volatile carbon, O_2, and H_2

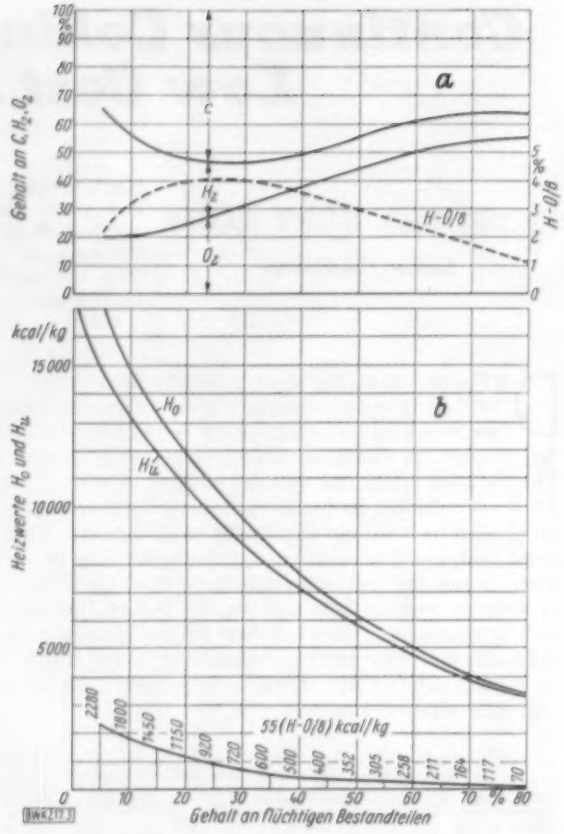


Fig. 3.—Composition and heating value of volatile matter versus volatile content of Fig. 2. Curves show (a) element composition, (b) heating values

Theoretical Analysis of Autogenetic Coking

At the International Meeting for Applied Chemistry—XII in New York in 1951 the difference between the air and gas quantities produced by gasification processes as against combustion processes were discussed.[1] It was pointed out then that because of the different levels of exothermal reactions the sensible heat contents would differ.

The theoretical reaction temperatures can be found from these sensible heat contents and will not differ materially if partial combustion is restricted to the volatile matter only. Under this restriction the reaction temperatures, as shown later, would prove completely sufficient to produce and transfer the heat required for coking the solid fuel.

The results of the somewhat complicated calculations to establish the basic laws for autogenetic coking of various fuels are presented in graphical form, Figs. 2–8. These graphs furnish helpful information for a designer to determine the coking output, the furnace capacity, the theoretical and actual operating temperatures, the expected gas composition and other data for this direct coke-making process. All other information on coking published to date is on the indirect heating of a fuel charge by convection and radiation.

Establishing Basic Theory. Beginning with Fig. 2 the basic element composition of the usual solid fuels in relation to their volatile content has been established and in Fig. 3 the heating value of the volatiles is pictured. These graphs permitted a determination of the total heat content of the volatile matter, Fig. 4. In the sample case selected to establish the theory of autogenetic coking the fuel chosen had an average composition of 87 per cent organic products, 8 per cent mineral and 5 per cent moisture.

Fig. 5 shows the important values for this fuel. The amount of air required, (c), the amount of gas produced, (b), the heating value of the gas, (d), and the calculation of the sensible heat content of the gas, (e), resulting from partial combustion and gasification of the volatile make up the curves on this illustration.

The values portrayed by these curves are theoretical ones and had to be adapted to give practical operating results. This was achieved by two modifications: (1) in addition to transformation of volatiles in the sample fuel 10 per cent of the fixed carbon (as a maximum in view of ash content) was considered gasified in the partial combustion process; (2) an allowance of 470 Btu per lb was made for radiation heat losses. This allowance was established by large scale tests on continuous stoker coking plants. Fig. 6 shows the results of these modifications on Fig. 5 values.

With temperatures of about 2200 F needed to produce and transfer the required coking heat and a final coke temperature of 1850 F curve (a), Fig. 6, shows that only fuels with 15 to 45 per cent volatile matter can reach or exceed the needed reaction temperature. All other fuels cannot form coke continually under autogenetic conditions.

If, however, the partial combustion of volatiles and 10 per cent fixed carbon in the fuel is regulated in such a manner as to hold the actual reaction temperature at around 1850 F then the full range of fuels can be transformed into high temperature coke, Fig. 7, or charcoal in the case of the younger fuels. Under these regulated conditions the gas produced, however, attains a heating value, (b), upon cooling to standard conditions that varies widely. Only in the case of these coals with from 15 to 45 per cent volatile matter is the heat content of this gas high enough to be combustible. The heat bal-

[1] "The Complete Gasification of Pulverized Carbon Containing Substances in Suspension," by Dr. Ing. Kurt Baum.

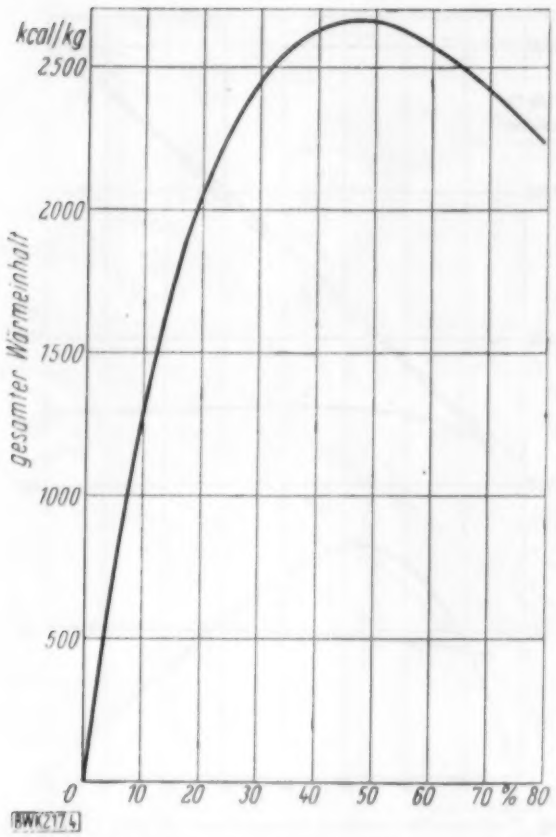


Fig. 4.—Total heat content of volatile matter versus volatile content of a selected fuel with 87 per cent organic materials, 8 per cent ash, 5 per cent moisture

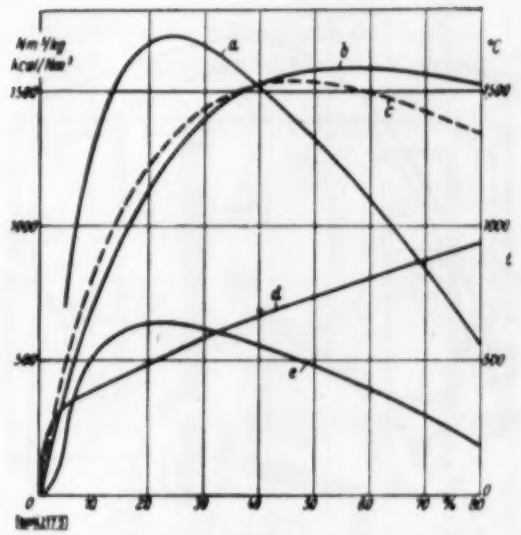


Fig. 5—Theoretical quantities and properties of the gas and air required for partial combustion of the volatile in the fuel of Fig. 4. Curves show (a) theoretical reaction temperature, (b) gas produced, (c) air required, (d) lower heating value of gas, (e) theoretical sensible heat content of gas

ance plotted in Fig. 8 for the conditions of Fig. 7 shows that the total heat content of the fuels split into many parts by coking add up again to their initial value.

Established Conclusions

The above basic relationships indicate a number of definite conclusions:

(1) The autogenetic reaction with restricted air quantities gives off sufficient heat for coking most types of solid fuels regardless of volatile content.

(2) Very low volatile coals and anthracite, including such briquettes, require additional heating fuel for coking since even complete combustion of all available volatile is not enough to produce the required coking heat.

(3) Bituminous coals within the range of 15 to 45 per cent volatile matter give off, under autogenetic coking, a combustion gas of low heating value, roughly comparable to the quality of blast furnace gas.

(4) Brown coal, peat and wood can be transformed into charcoal or coke only by augmenting the partial combustion within the fuel bed by more complete combustion of the volatiles in the area above the fuel bed. The gas produced has a higher sensible heat content than with higher grade fuels but it is non-combustible upon cooling to standard conditions.

(5) All fuels for autogenetic coking should be air dry. Any required evaporation of moisture with its attendant high heat requirements reduces the reaction temperature and gas quality. For example, a moisture content above 10 per cent makes it impossible to reach the minimum reaction temperature of about 1850 F. (NOTE: This is in contrast with the counterflow heat exchange between hot reaction gases and the fuel in gas producers employing stationary fuel beds.)

(6) The established relationships hold equally valid for mixed fuels such as minerals and coals in the form of briquettes and compressed pieces. The overall volatile content of the product (coal, ore, binding agent) governs.

(7) Where partial combustion of volatiles within the fuel bed cannot supply the required heat for coking, final combustion of the gases should be accomplished with secondary air above the fuel bed. This maintains a reducing atmosphere in the fuel bed and avoids reaction of fixed carbon with excess air and reaction with free oxygen in the fuel bed.

Practical Applications

There are a number of industrial applications based on carbonization of fuel to coke, or gas, where the autogenetic coking process might prove worth while. Further, the sensible and latent heats evolved can be used for steam generation. The following give some indication of these applications.

I—Autogenetic coking for coke production opens up these interesting possibilities: (a) The range of suitable bituminous coals is considerably increased. Coals that will not coke under slow heating in an indirect fired oven form an excellent coke under rapid heating on a stoker bed. This holds especially true for mixed fuels, Fig. 6, where coking properties are instrumental in producing hard and strong coke. The coke from caking coals—about 90 per cent above $^{3}/_{8}$-inch—can be used, depending on local conditions, for all kiln operations, for producing water gas and for chemical processes.

(b) Char of a strong reactive capacity can be produced from non-coking, high volatile coals. Wherever

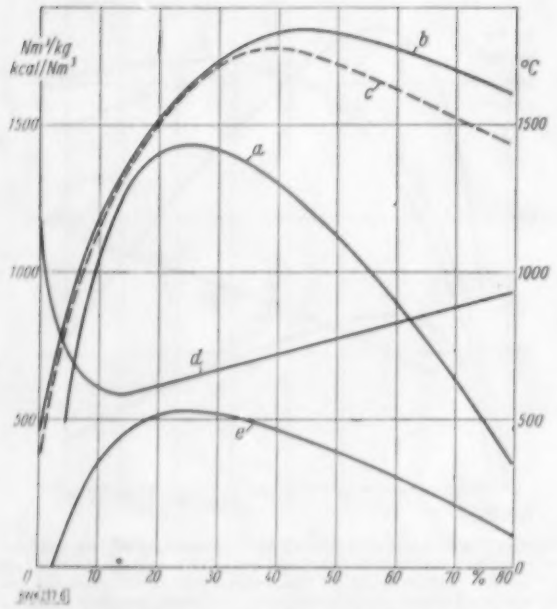


Fig. 6.—To convert theoretical values of Fig. 5 to practical operating results 10 per cent of fixed carbon is gasified and radiation losses included. Curves show (a) actual reaction temperature, (b) gas produced, (c) air required, (d) lower heating value of gas, (e) theoretical sensible heat content of gas

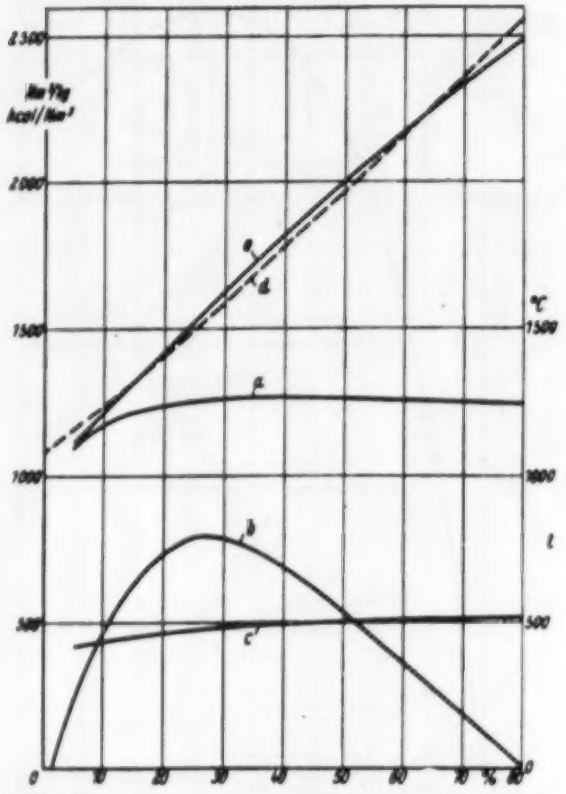


Fig. 7.—Effective reaction temperature of 1200 C (2200 F) results in the above quantities and properties for the materials involved: (a) actual reaction temperature, (b) lower heating value, (c) actual sensible heat content, (d) air required, (e) gas produced

carbon is to react with elements such as CaC_2, P, Si, or where high reactive capacity for reducing or sintering ferrous or non-ferrous ores is of value this char applies. The autogenetic system of char production is by far the lowest cost one of any known method.

(c) Solid mixed coke products can be handled suitably. The reducing atmosphere of this process will, to a smaller or larger extent, reduce the mineral fines. This delivers either an intermediate product for a chemical end reaction or achieves a direct reduction to the metal.

II—The heat content of the hot reaction gases from the autogenetic coking process can be employed in these ways:

(a) The most effective use of the hot gases is as a fuel for steam generation. Exploitation of the sensible heat and of the heating value of the reaction gases represents the best form of thermal transformation. In comparison with steam generators fired by solid fuels gas fired units require less investment, Fig. 9. The amount of reaction gases given off vary with the coal used but the process can supply gases of enough heat content for generation of 325 to 860 kwhr per ton of coke produced.

(b) Industrial heating requirements such as burning of lime, cement or calcination of minerals, Fig. 10, are excellent applications for the hot gases.

(c) Contact drying or calcination of wet minerals or coals with high moisture content such as brown coal, peat and wood, Fig. 11, can be effectively accomplished by the hot gases. The dried fuel is then degasified in the coking stokers.

(d) Indirectly heated ovens, such as coking ovens, for one, can be fired by hot gases. The gas from the dry distillation process is available for higher rated purposes such as city gas or chemical process gas. The additional coke production can be turned to additional income wherever the market offers a large price differential between coke and coal.

(e) Reaction gas from the bituminous coals in the autogenetic process after being put through a waste heat boiler, a gas washer and cooler compares roughly with blast furnace gas in quality. It can then be used for heating or power purposes. It might even be carbureted or mixed with high quality gas for public utility distribution.

Economic Considerations

Despite the fact that local conditions influence the construction costs of an autogenetic coking plant and the materials employed similarly can vary widely in price there are enormous savings in coking costs as compared with standard coking plants. The plant proper varies between $2.5 and $4.5 per metric ton of yearly coke production depending mainly upon the utilization of the by-product gas. By-product coking plants, on the other hand, require $25 to $28 per metric ton of yearly production. The extent of required auxiliary equipment is also much less with autogenetic coking. As a result the autogenetic system enjoys considerably lower amortization and interest charges.

Labor costs, maintenance and other incidentals add up to only a fraction of the same charges with the standard intermittently charged coking plant because the

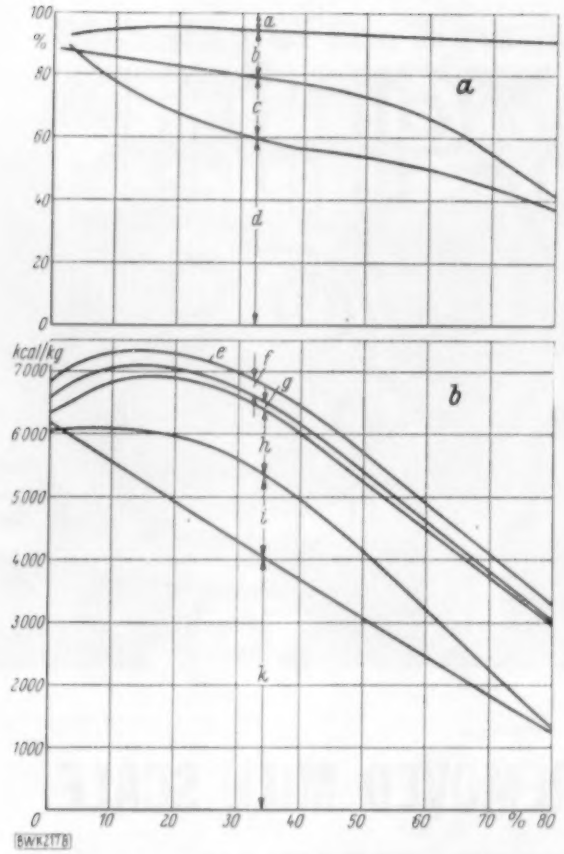


Fig. 8.—Heat balance of autogenetic coking per kg of coal versus volatile content of fuel presented in percentages in curve set, a, where (a) is heat loss by radiation and sensible heat in coke; (b) is sensible heat in gas; (c) latent heat in gas; (d) latent heat in coke. Curve set, b, shows heat balance in kcal/kg and (e) gives heating value of fuel; (f) heat loss by radiation; (g) heat loss in sensible heat in the coke; (h) sensible heat in the gas; (i) latent heat in the gas; (k) latent heat in coke

autogenetic process is continuous and automatically controlled.

Basing comparisons on equal costs for high quality fuel the coke price by the autogenetic method appears to be from $2 to $3 lower per metric ton despite the loss of by-product sales revenue and the fact that coke oven gas is fairly valuable in Europe.

Industrial autogenetic coking plants can be built like standard traveling grate stokers for outputs from 1 to 10 or 20 to 250 tons per day in a single unit. Operational availability and flexibility are important additional advantages. With such standard equipment units can be started up and reach full load within a four-hour period. And the units can be shut down as readily.

From the maintenance standpoint the normal process temperatures of around 2300 F should create no refractory difficulties. Occasional grate bars, roughly one per 5 metric tons of coke production, may need replacing which is not a serious task.

In summation, the transformation rate of coke to coal of 37 to 61 lbs per sq ft per hr by this method as against the dry distillation average of 2.1 to 2.5 lbs per sq ft per hr should give autogenetic coking decided advantages.

Possible Applications of Evolved Heat From Autogenetic Coking

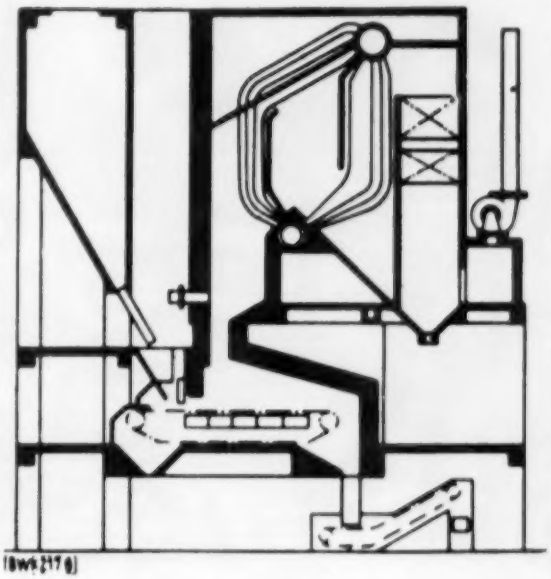


Fig. 9—Coking stoker combined with a steam generator

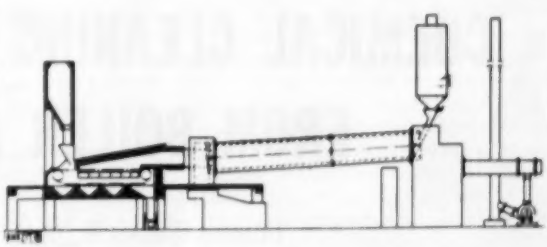


Fig. 10—Coking stoker connected so sensible and latent heat of reaction gas goes to fire a rotary kiln

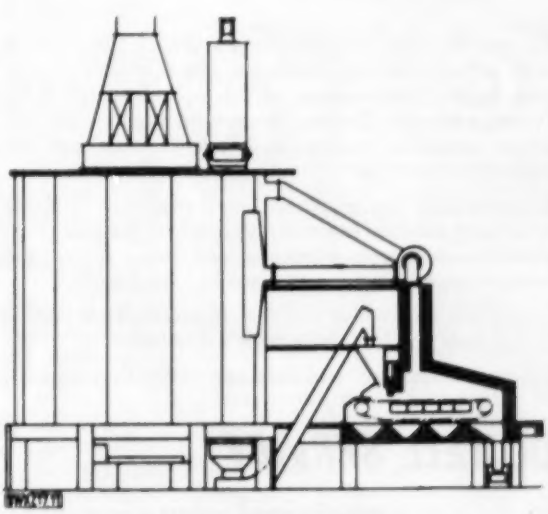
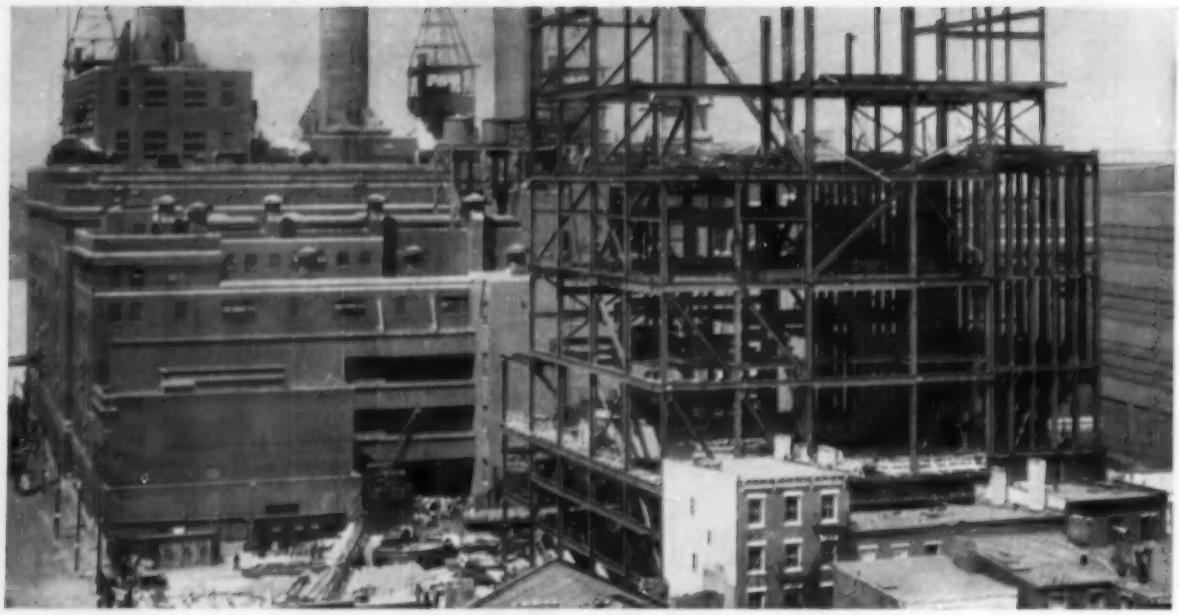


Fig. 11—Coking stoker above has its hot gases used for drying raw brown coal in cyclone dryer



CHEMICAL CLEANING REMOVED MILL SCALE FROM BOILER AFTER ERECTION

Dowell Service gave quick, effective cleaning assuring more efficient operation

To provide more extensive service for its customers, a large power company installed a new 1,370,000 lb. per hour boiler. Specifications on this equipment called for Dowell Chemical Cleaning Service to remove any oil, grease, protective coatings, mill scale and rust from the boiler after erection.

To accomplish the purpose, Dowell engineers filled the boiler with solvents especially designed for the job. Using Dowell's equipment, manpower and pump trucks, the entire cleaning job was performed in a few hours.

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Meaning of the New Atomic Energy Act

ON September 27–28 The Atomic Industrial Forum, Inc., conducted a meeting on "The New Atomic Energy Law—What It Means to Industry" at the Plaza Hotel in New York City. Total attendance exceeded 500 for sessions presenting such subjects as interpreting the law, investment opportunity, individual company forecasts, industry-government partnership, the role of the AEC, labor outlook and insurance problems of the atomic industry.

At the same meeting J. L. Atwood, president of North American Aviation, Inc., and Broderick Haskell, vice chairman of Combustion Engineering, Inc., were elected to the board of directors of The Forum. Admiral Earle W. Mills, president of Foster Wheeler Corp., was elected as a new Forum vice president to serve along with the following re-elected officers: Walker L. Cisler, president; Dr. F. L. Hovde, vice president; Alfred Iddles, vice president; Charles Robbins, executive manager; Oliver Townsend, secretary and assistant executive manager; and Russell G. Vernon, treasurer.

Industry-Government Partnership

"The New Industry-Government Partnership in Atomic Energy" was the topic of an address by T. Keith Glennan, president of Case Institute of Technology, a former AEC Commissioner and one of those most responsible for the formation of The Atomic Industrial Forum. Pointing out that the government monopoly in atomic energy is gone, he stated that the central problem for the Government is to recognize that not only is there a new letter to the law but also that there is a new spirit. It is particularly important that this new spirit be appreciated, felt and prevail in all parts of the Government. Dr. Glennan urged that a positive approach be followed along these lines:

"The law of the United States, and therefore the basic policy under which we operate, has been changed to permit and encourage others to carry on work in the atomic energy field. As public servants, it now becomes our responsibility, not only to regulate these non-government activities in the interest of security and safety, but also to help them in every way that we can. At times this will be tedious; at times it will be difficult; almost always it will be bothersome. But our problem now is not to decide whether we should be helpful; our problem instead is one of determining just how we can extend the greatest possible help in the most equitable way."

Recognizing that the Government is the repository of nearly all of the latest and best atomic energy knowledge, Dr. Glennan suggested that what is done in the area of information dissemination will be indicative of whether the Government regards industry as a true partner or something much less. In practice, he added, the AEC "must now permit people outside of its own program who are not government risks to have access to the classified information which they will need to educate themselves in atomic energy and to undertake projects which they—and not necessarily the government—will consider to be worth while, and on which they—and not the government—will risk the money."

Implementing the New Law

Dr. Lawrence R. Hafstad, director of the AEC Division of Reactor Development, reviewed the present situation from the standpoint of government and industry programs and with respect to possibilities in the international field. He expressed the belief that the government should push work in solving problems of fuel-element fabrication and chemical reprocessing. These are also areas well suited for industrial attack and ones in which trade secrets, technical knowledge and engineering experience may make the difference between success and failure.

With respect to the industrial program, Dr. Hafstad felt that this was a time to be a little critical of the lack of initiative on the part of industry. He pointed out that reactor study groups had been in existence for three years and that industry was aware that changes in the law were forthcoming. The new Act permits *action* now, so Dr. Hafstad appealed for an aggressive program of industrial reactor building instead of a leisurely period of further study. In the following terms he urged utility companies and equipment suppliers to take the initiative:

"If there is anything at all in this atomic energy business, then industry ought to push hard in it and find out what the answers are. Industry should not be willing to let the government organizations just coast with this thing, piddle with it over the years, and eventually decide what can and cannot be done. . . .If the nation really needs the brains and imagination of American industry to get the answer, then American industry ought genuinely to get into atomic energy and see what the future really is. If there is no future, it ought to be learned quickly so that we can stop the whole business. This is a very expensive experimentation game we're engaged in."

Answering the question as to how industry should get started, Dr. Hafstad urged equipment manufacturers to get busy and do a sales job particularly on research reactors. In connection with the development of fuel elements, he suggested that industry take the initiative to design, finance and build an engineering test reactor. He also mentioned his earlier "reactor-of-the-year" proposal as an avenue upon which utility companies could take the initiative adding this statement:

"Today we should be *building* atomic power plants. We have passed the time when we can get along with paper studies and economic analyses."

Commenting on the international program, Dr. Hafstad stated that, contrary to the general impression in this country, the Europeans are very well versed in the atomic energy field and do not need our secrets to make progress. They have considerable scientific and technical knowledge and even greater incentive because of prevailing higher fuel costs. He added that the European nations will be prepared to compete with American industry for the market in the undeveloped countries for both research and power reactors.

Interpreting the Law

Everett L. Hollis of the General Electric Co. stated that the act does two main things:

1. It affords private industry a larger role in the development of atomic energy.

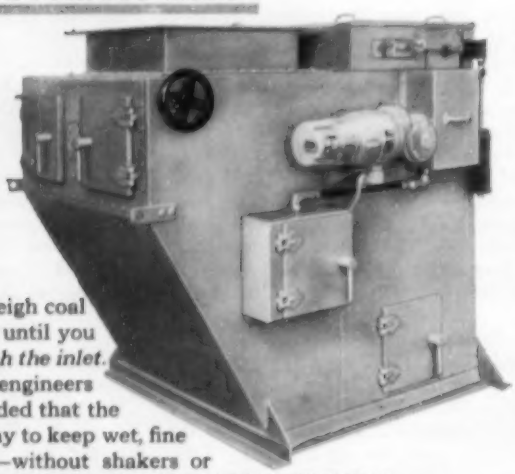
2. It provides a framework for a greater degree of cooperation with other nations in the field of atomic energy.

One of the most important changes is the fact that the Government monopoly in the field of atomic energy has been substantially reduced. While the new act continues to stress the necessity for close Government scrutiny, it moves in the direction of control by regulation rather than by Government ownership. Mr. Hollis emphasized the act does not remove the Government from civilian atomic development and that it does not represent a shift of authority and responsibility from the Government to industry. The concept of the act is that both

the hourglass shape...

...it may have been fine for Fannie,

but it has no business here!



You can't weigh coal in *any* scale until you *get it through the inlet.* Richardson engineers have concluded that the only sure way to keep wet, fine coal flowing—without shakers or vibrators—is to make that inlet BIG ENOUGH. So they opened up the "wasp waist" to a full 24″ x 24″, and around it they built the best coal scale it was possible to develop from fifty years' experience, the Richardson H-39.

If you're interested in maximum coal scale *efficiency* at wholly reasonable cost, specify a 24″ x 24″ minimum, and *know* that your coal will flow. That is the starting point from which the H-39 is soundly engineered in every feature, every detail. It's built as a coal scale *should* be, from the inside out, with a full 4 square feet of inlet. Get all the details, mechanical specifications, and drawings in Bulletin 0352.

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Government and industry must work cooperatively and concurrently in atomic development, the key to success being teamwork

In his concluding remarks Mr. Hollis observed that industry has both opportunities and obligations to carry out the new national atomic energy policy. In addition to efforts on scientific and technological fronts, industry must also use its ingenuity and imagination in devising legal, economic and financial techniques for fitting the civilian atom into the normal framework of American life.

Bennett Boskey of the law firm of Volpe, Boskey & Skallerup discussed patent provisions of the new act in some detail. A basic change is that fissionable material, termed "special nuclear material" in the new act, has been restored to the patent system. He added that this development along with other provisions of the act makes it possible for private enterprise, pursuant to a licensing system administered by the Atomic Energy Commission, to invest in and to own and operate facilities in the field of production of special nuclear material and of power.

Investment Problems

Speaking on this subject, **Armand G. Erpf** of Carl M. Loeb, Rhoades & Co. suggested that the following curbs or restraints are in order:

1. When speaking of atomic energy and its possible future applications, scientists should heavily emphasize the uncertain time factor.

2. In preparing annual reports industrialists should, without betraying secrets, give some idea as to the amount of money and number of men involved in atomic energy programs together with the prospects for making an economic return.

3. The AEC should decide how much can be told about the purely financial aspects of atomic energy. He pointed out that the financial community knows little if anything about the technicalities of the chemical or electronics industry, yet it has adequate yardsticks by which to judge.

What Industry Sees Ahead

W. E. Kingston of Sylvania Electric Products Inc. pointed out that his company is in the nuclear fuel and reactor component business and is continuing to make available complete "out-of-pile" services to reactor designers, constructors and operators. Although great strides have been made in the past several years in improvement of fuel materials and methods of fabrication and assembly of fuel elements, Mr. Kingston expressed the belief that the field of reactor materials is and will continue to be one of the

greatest limiting factors in advancing nuclear power. Yet he felt confident that advances will be made permitting low-cost nuclear energy to become a reality within five to ten years.

Continuing the discussion of what industry foresees, **Eugene B. Hotchkiss** of Vitro Corp. of America paid tribute to the Atomic Energy Commission and its predecessor, the Manhattan District, for setting a pattern of cooperating with private industry that is contributing toward a smooth transition to a civilian atomic industry. His company, which accumulated on the order of 7500 man-years of experience in the course of government contracts in atomic applications, is interested in the field of reactor processing, including radioactive waste disposal, and in the field of the design and engineering of power reactor installations.

John W. Landis of The Babcock & Wilcox Co. reported that his organization is devoting a significant portion of its facilities and resources to atomic energy work. Although the new Atomic Energy Act has certain patent defects and administrative cumbersomeness, it is a long step in the right direction, and proper action in industry should result in future legislative action that will return more of the atomic energy realm to free enterprise. Mr. Landis expressed the belief that within the next year his company would be prepared to quote firm on four types of reactors, and he predicted that under the recent "share-the-expense proposal" of Dr. L. R. Hafstad, AEC director of reactor development, four or five companies will initiate power reactor projects within the next two years. Over approximately the same period he predicted that on the order of twenty research and/or package power reactor projects will be started in this country.

With respect to industry activity in the field of international atomic energy, **John R. Menke** of Nuclear Development Associates, Inc., stated that peacetime atomic power, as an instrument of foreign policy, has a good will value almost without equal. The world market for power reactors can be divided into the industrialized nations which are relatively short on fossil fuels and those nations in the less developed areas having high fuel costs. Mr. Menke pointed out that the industrialized group is richer in technology and capital and is capable of building and operating its reactors with little U. S. assistance. On the other hand, the less developed countries require that means be found to export not only technology but also the capital to pay for the new assets.

Concluding the discussion of the meaning of the new atomic law to industry, **Arthur V. Peterson** of American Machine & Foundry Co. stated that the Act of 1954 clears away many of the imponderable questions facing a company entering the atomic energy field. It provides a basis for planning through the establishment of basic rules under which it is possible to formulate programs for analysis and consideration by company management. He expressed the belief that as more companies become interested and more men and money are invested, new atomic developments and applications will grow at an accelerating rate. Mr. Peterson outlined his own company's five-year program, beginning with the establishment of an atomic energy group in 1953 and progressing on to research reactors, small package reactors, and work on equipment and mechanisms for large power reactors.

The full proceedings of the meeting will be made available by the Atomic Industrial Forum, Inc., 260 Madison Ave., New York 16, at $5.00 per copy to non-members and free to members.

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With a Sauerman roller-bearing hoist located directly beneath him, he controls the operation from the hoist house by means of reach rods connected by levers to the load and backhaul drums. The scraper is shifted by moving a tail block to another ring on the bridle cable.

When stockpiling, coal is built progressively outward from the initial pile, which is created by an inclined conveyor. The Crescent Scraper bucket automatically "layers-in" the coal to prevent voids which form dangerous air pockets or flues. This compact piling means good protection against spontaneous combustion.

Sauerman scraper storage is economical storage. Maintenance costs are low. You eliminate the power cost involved in moving heavy machinery around the storage area. Only the steel plate bucket and wire rope contact the coal. One employee, available at all times to perform other duties, controls the Sauerman machine from a safe location overlooking the stockpile.

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Business Notes

The Power Plant Service Division of **Magnus Chemical Co., Inc.** has been appointed sole distributor for Thiodene, a new substitute for starch indicator solution developed in England. A few tenths of a gram added to an iodine titration serves as well as a milliliter of starch solution.

The Lunkenheimer Co., Cincinnati, Ohio, have embarked on a program of expansion and consolidation. All manufacturing operations, according to its president, P. M. Arnall, will be consolidated at the company's Fairmount plant at Cincinnati. This consolidation will necessitate an expansion of the Fairmount plant facilities.

American Society of Mechanical Engineers recently established a Nuclear Engineering Committee to coordinate the Society's activities in those areas of mechanical engineering where a knowledge of nuclear physics is essential. Such areas include core design, shielding, waste handling, fuels and fuel fabrication, radiation effect, special equipment and operation of nuclear power plants. Albert C. Pasini, assistant general supt. of production, Detroit Edison Co., is its chairman.

Battelle Institute, Columbus, Ohio, announced plans for a $1,535,000 expansion of its nuclear-energy research facilities. The new facilities would serve for enlargements of the Institute's contract research for industry and government in the atomic-energy field. Construction of a nuclear reactor, a reactor development laboratory and a nuclear fuels laboratory is scheduled to begin shortly. The laboratories will be located on a 397-acre tract of land near Jefferson, Ohio, fifteen miles west of downtown Columbus, according to Dr. Clyde Williams, Battelle president.

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Lewis L. Strauss, chairman, **Atomic Energy Commission,** made public the authorization of a nine-company nuclear power study group known as the Rocky Mountain Nuclear Power Study Group. This study group, the sixteenth currently authorized, is composed of: Arizona Public Service Co., Ebasco Services, Fluor Corp., Idaho Power Co., Minnesota Mining and Manufacturing Co., Phillips Petroleum Co., Public Service Co. of Colorado, Riley Stoker Co., Utah Power & Light Co.

General Electric Co. recently dedicated a $3,500,000 turbine development laboratory at Schenectady. Both high- and low-pressure sections of steam turbines will undergo development and in addition generator fans, hydrogen seals, turbine steam seals, oil pumps, bearings and other turbine components will receive study.

Sargent & Lundy Co. have been selected as architect-engineers for the design of the Experimental Boiling Water Reactor, according to the Argonne National Laboratory. **Allis-Chalmers Mfg. Co.** has been chosen to design, develop, construct and install the power generation, heat transfer, and special equipment for the power cycle.

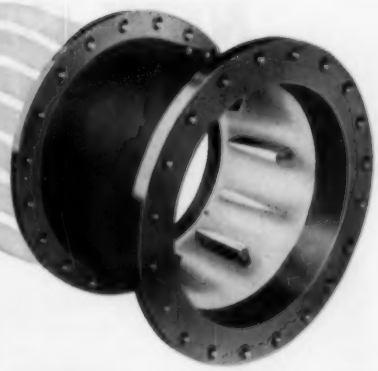
The St. Clair Power Plant of the **Detroit Edison Co.** with a capability of 625,000 kw was dedicated in a ceremony before an audience of about 400. This station, the fifth and largest of the system's plants, was designed for improved efficiency to offset high fuel prices and its fuel consumption will run about three-quarters of a pound of coal per kwhr.

Over four hundred exhibitors have lined up displays for the Jan. 24–28, **12th International Heating and Ventilating Exposition,** to be held at the Commercial Museum and Convention Hall, Philadelphia, with the 61st annual meeting of its sponsor, the American Society of Heating and Ventilating Engineers. These exhibits will cover the full range of the society's interests.

Secretary of the Interior Douglas McKay ordered three Bureau of Mines technicians to proceed to Los Angeles as of October 28 to aid in the fight against the smog menace there. This action followed a request from Governor Goodwin J. Knight of California.

Louis C. McCabe, now chief of the Bureau's fuels and explosives division and earlier director of the Los Angeles County air pollution control dept., John F. Barkley, chief of the Bureau's fuels utilization dept., and Richard C. Corey, chief of fuels technology at Pittsburgh will confer immediately with Governor Knight's smog committee.

FOR *LOWEST* HEAD LOSS IN FLUID METERING



The *Gentile FLOW TUBE**

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WHERE HEAD LOSS IS IMPORTANT...The Gentile Flow Tube can be designed to produce a measurable differential with lowest permanent pressure loss of *any* head meter.

ACCURACY... Differential is produced from points of equal cross-sectional area. Furnished with head capacity curves, and guaranteed for exceptional accuracy when used with any standard indicating, recording or integrating meter.

REVERSIBILITY...When the flow is reversed, the differential is reversed. Permits metering reverse flow at lowest possible equipment cost.

LOW INSTALLED COST...Average length is only 1½ times the pipe diameter, and straight runs entering and following are not required unless installed near throttling valves or regulators.

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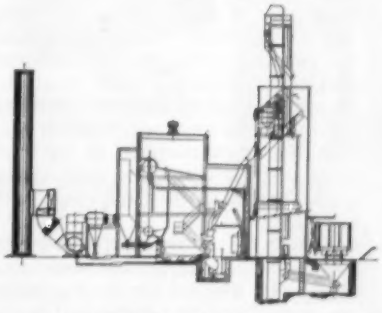

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NEW CATALOGS AND BULLETINS

Any of these may be secured by writing Combustion Publishing Company, 200 Madison Avenue, New York 16, N. Y.

Skip Hoists

Newly completed, 16-page color Bulletin No. 110, by the C. O. Bartlett & Snow Co. shows sequence views of operation of the weigh type and plug feed loading gates, lists capacities of various sized buckets, traveling various lifts at various speeds and describes hoist engines, sheaves, head frames and counterweights.

Water Treatment

Six-page Bulletin No. C-117-Z, released by the Pacific Lumber Co., describes two organic chemicals, Palcotan and Palconate, reactive chemicals derived from redwood bark and said to be effective as dispersing agents and replacements for phenol, quebracho and other tannins. Most of the subject matter in the bulletin discusses industrial process applications.

Gas Reformer

Bulletin E-30, a 12-page description of the Koppers Co., Inc. Koppers-Hasche reforming furnace, gives details of a process for producing interchangeable gases at low cost. The unit is said to answer the need for a dependable, flexible means of supplying gas replacements for interrupted manufactured or natural gas supplies. A feature of the booklet is a flow diagram in color of the reformer operation.

Valves and Gages

Condensed catalog No. 236, released by the Jerguson Gage & Valve Co., covers practically the complete line of the manufacturer's liquid level gages and valves with a condensed presentation of the pertinent data and specifications. Included are illustrations of the various standard and special functions of the equipment.

Welding Book

The latest developments in the science of welding aluminum are covered in a recently released 176-page book entitled "Welding Alcoa Aluminum" available from Aluminum Co. of America. Photographs and drawings are coupled with the text to illustrate all the practical methods for welding aluminum. These include torch welding, arc welding, resistance welding and pressure welding. Special attention is given to selection of welding method, performance of welds and control of welding quality.

Variable Speed Drive

Catalog M-543 of the Reeves Pulley Co. describes in 24 pages the company's new design of fractional horsepower Vari-Speed Motodrive. The catalog outlines the operating features, gives list prices of all units, controls and modifications. It is available in $^1/_6$-, $^1/_3$-, $^1/_2$-and $^3/_4$-hp capacities in speed ratios of 2 : 1 through 10 : 1. A total of 112 different assemblies are available. The new unit comes in vertical, horizontal and 45-degree models, all described in the catalog, and at speeds of from 3 to 4660 rpm.

Plug Valve Actuators

Ledeen Mfg. Co. has released an 8-page bulletin, No. 3020, on plug-valve actuators. This bulletin describes tandem type actuators for valves requiring relatively high torques to operate and new floating-bar actuators for use on valves requiring lower operating torques. Selection tables, typical applications, dimensions and weights, various mounting possibilities complete the publication.

Steam Condensers

Design and engineering features of Allis-Chalmers Mfg. Co. condensers for every type of application in sizes from 100- to 125,000-sq ft make up the subject matter of the 24-page Bulletin, 19B 7987, recently made available. Illustrations are furnished of the many types—conventional, single elbow and twin inlet—manufactured by the company and sketches show some of the major features of the multi-steam path condenser.

Backwash system for single- and two-pass condensers, air-removal equipment specifically designed for steam condenser service including single- and multiple-jet ejectors and motor-driven mechanical vacuum pumps are described as are condensate and circulating water pumps in both horizontal and vertical designs.

Solenoid Valves

The new 4-page bulletin, M-500, covering design and performance characteristics of the Eclipse Fuel Engineering Co., DO line of diaphragm-operated solenoid valves, has recently been released. It contains photographs, line drawings, specifications and tables for the six pipe sizes—$^3/_8$-, $^1/_2$-, $^3/_4$-, 1-, $1^1/_4$- and $1^1/_2$-in.—in which the valves are made up.

Specifications cover valve use in control and cycling operation on equipment using air, oil, water, refrigerants, natural, manufactured and butane, and propane gases.

Dynamometer Systems

A revised 12-page Bulletin, GEA-5923A, of the General Electric Co. tells how the company's dc dynamometer systems can be used for testing internal combustion engines, transmissions, torque converters, pumps, fans, electric motors and compressors. Data are provided on the system's wide speed and torque range ability.

Pumps

The heavy duty, cradle-mounted-unit centrifugal pump assembly marketed by the Warren Steam Pump Co., Inc. is the subject of the 4-page Bulletin 247 recently released by the manufacturer. It includes basic design and construction features, sectional and external views, composite dimensions and material specifications.

Motor Pulleys

Reeves Pulley Co. have covered the complete redesign of their standard line of Vari-Speed motor pulleys in their 24-page catalog, V-545. The design engineered for the new NEMA frame motors, but also usable with old NEMA motors, comes in eight sizes ranging from $^1/_3$- to 15-hp and in speed ratios as great as 4 : 1.

Disk assemblies for each hp rating have been made smaller and a new threaded spiral groove lubrication system has been installed that permits lubrication at one point. The catalog offers descriptions and supplies details of these new features.

Steam Turbines

The development of the steam turbine from its infancy, as originally described in a series of articles by R. C. Allen appearing in the *Allis-Chalmers Electrical Review*, has been collected in the special publication "Steam Turbine Highlights," No. 03R8145, and is available through Allis-Chalmers Mfg. Co.

Needle Valves

Design details and operating characteristics of the Foxboro Co. line of needle valves comprise the material in the recent 8-page bulletin. 5C-13, available

from the manufacturer. Engineered for applications requiring precise control of low rates of flow the bulletin gives a table of nominal needle sizes with corresponding valve coefficients, and characteristic curves showing per cent of maximum flow in relation to per cent of total lift. Formulas and instructions for calculating the size of a suitable valve are included.

Industrial Television

The Diamond Power Specialty Corp's Utilivue, a closed-circuit industrial television camera, is described in the 4-page bulletin No. 1175 put out by the device's distributor, Graybar Electric Co.

The series 400 Utilivue camera can be used with a Video monitor or a standard TV receiver and can be tuned to any channel from 2 to 6. All controls and power supply are built into the camera with no separate power unit or multiconductor cable needed.

Electrolytic Conductivity

Portable electrolytic conductivity indicators for measuring the purity of condensate or various other solutions make up Data Sheet E-95 (1) now available from Leeds & Northrup Co. Photographs and circuit diagrams illustrate the design and operating features of each instrument. Specifications for both indicators and recommended cells are listed.

Water Treatment

An easy-to-read elementary introduction to the advantages of water treatment characterizes a new 6-page folder, "Primary Water Treatment," released by the Hall Laboratories, Inc. The folder mentions the methods of treatment available and the potential trouble makers which untreated water can introduce to a plant.

Mechanical Drive Turbines

Cutaway, schematic drawings, and photos of the mechanical drive turbine Type DP, rated from 10- to 1200-hp and 1000 to 6500 rpm, are supplied in the General Electric Co. 20-page bulletin, GEA-4955B, describing this class of equipment. Special design features as well as applications for pumps, compressors, fans, blowers and similar devices also appear.

Unit Heaters

Bulletin 7517 recently released by the American Blower Corp. covers in 48 pages the latest designs of their Venturafin unit heaters. Features of the design, general engineering data, capacity tables and piping diagrams are among the pertinent data furnished.

Make boiler water level reading
positive—mistake-proof—with
EYE-HYE
Remote Reading Indicator
Gage reading at eye-height any reasonable distance from drum
Easy to read, like conventional gage
Illuminated green fluid gives sharp clear indication
Simple, manometer principle, no complicated working parts
Easy to install, practically no maintenance
Models for all pressures, from 0 to 2000 pounds
Reliance EYE-HYE
Panel-mounted EYE-HYE
Wall-mounted EYE-HYE
Write for full data on EYE-HYE—tell us working pressure and control location
Complete line of Water Columns, Gages and other trim for all working steam pressures.
The Reliance Gauge Column Co., 5902 Carnegie Ave., Cleveland 3, Ohio
Reliance EYE-HYE
Remote Reading Gage

Consultant Service

A brochure produced by Gilbert Associates, Inc., indicates in words and pictures the services offered by this organization of consulting engineers in the continental United States and throughout the world.

Industrial Fans

A 4-page bulletin, No. 702, released by the Clarage Fan Co. describes the company's new XL industrial fans. The design employs three interchangeable wheels, each with radial blades, and is available in two broad range classifications.

The bulletin describes the elements comprising the two size ranges, pictures the wheel construction, describes some of the fabrication features and presents tables on general data as well as specific information on performance for other than standard conditions.

Supercharged Cooling

"Progress Report. . . Supercharged Cooling Today!," publication No. 05R-8168, of the Allis-Chalmers Mfg. Co. is the three-year experience record in supercharged internal conductor cooling of steam turbine generators that originally appeared as an article by L. T. Rosenberg in the first quarter 1954 issue of *Allis-Chalmers Electrical Review*. The report points out that while supercharged cooling is best suited for 3600-rpm units because of the favorable blower speed it may eventually be adapted for 1800-rpm generators as well.

Industrial Products

A 48-page, complete industrial products catalog, "Your Guide to Brake Shoe Products," the first in the history of American Brake Shoe Co., illustrates representative parts produced by eleven divisions of the company and details physical properties or characteristics. Sections are furnished on ferrous, nonferrous castings, bearing materials, sintered metals, welding products, air compressors, industrial and dredge pumps.

Pressure Recorders

Bulletin 6-10, Foxboro Co., is a 24-page presentation of the company's new line of pressure measuring elements designed for direct measurement, remote transmission and automatic control. An application chart shows how to select the measuring element and gives the wide choice of materials available. The high pressure helical for pressures to 80,000 psi, as well as the diaphragm, bellows, spiral and standard helical covering ranges from 10 in. w.g. to 6000 psi are diagrammed and explained.

VITRALLOY permits saving and re-use of more degrees of heat from flue-gas than possible with plain steel tubes.

Barrows

VITRALLOY
PREHEATER TUBES

What power engineer wouldn't like to have up to a 17% gain in heat transfer efficiency? Authentic and scientific laboratory tests say Barrows Preheater VITRALLOY Tubes (boro-silicate compound fused to base metal) make it possible. Wall thicknesses of both specimens tested (VITRALLOY and ordinary steel tubes) were identical. VITRALLOY also means no corrosion—therefore less clogging; fly ash deposits easily flushed with hot water. VITRALLOY cuts down-time and maintenance costs . . . up-grades boiler efficiency.

The problems of corrosion and clogging vary from one power plant to another. Let us tell you the complete story of Barrows Preheater VITRALLOY Tubes . . . and work with you on designing them to the needs of your own operation. Write:

BARROWS B P PORCELAIN

BARROWS PORCELAIN ENAMEL CO.
LANGDON RD. AND PENN. R. R. CINCINNATI 13, OHIO
Phone: REdwood 6000

Cathodic Protection

A reference work on the mitigation of corrosion of underground and submerged metal structures by application of an improved current cathodic protection system was the aim of the National Carbon Co. in publishing the new 12-page booklet, Catalog Section 5-6500. The booklet contains information on the cost of corrosion, the economics of cathodic protection, installation details as well as design notes and tabulation of material requirements.

Boiler Controls

The 4-page bulletin, 54-1088-239, of the Hays Corporation gives specifications for the fully automatic all electric metering type packaged control for shop-assembled boilers. A schematic drawing shows a typical packaged control system for a combination gas- and oil-fired boiler.

Valve Operators

A complete, new 21-page catalog, L-54, describes Limitorque valve operators and particularly the latest valve control for large or small valves as well as showing operational details and illustrations.

Gravity Filters

Specifications, operating instructions and characteristics, outline dimensions and typical illustration photographs supply considerable data in the 24-page bulletin, No. 2539B, put out by the Permutit Co. on gravity filters. The bulletin shows a complete line including filter accessories—manually operated, semi-automatic and automatic—including operating tables, rate of flow controllers and gages.

Hand Tachometers

New, 3-in-1 hand tachometers, now manufactured by the Metron Instrument Co. form the subject matter of the company's Bulletin No. 103. This device has three separate ranges on the one instrument and only one range appears at a time. A change from one range to another is accomplished by flipping a switch.

Temperature Regulators

A 12-page catalog, Bulletin S-6, released by the Lawler Automatic Controls, Inc., describes the manufacturer's type "S" thermostatic temperature regulator. The catalog explains where and when to use direct-acting, reverse-acting and three-way thermostatic temperature regulators and lists typical

engineering specifications. In addition help is given on where and how to use single- and double-seated valves.

Equipment Catalog

The Link Belt Co., in its 340-page standard products Catalog 950, employs a flexible cover and thumb index to make ready reference to its full line of products an easy operation for the engineer. There are many sections and several major classifications. These include, for example, chains and sprockets for conveying, elevating and power transmission. Tables are furnished to aid in selection. Enclosed gear drives are similarly presented with all the different drive forms covered. This same treatment carries throughout the company's products.

pH Bulletin

Complete instrumentation for pH measurement and automatic control constitutes the coverage in the 38-page Bristol Co. bulletin Q1304. Drawing and photos of installations in all fields are given. Further, much detail is supplied on the component elements in a complete pH system and accessories to carry out various functions used.

Gaskets

The latest in a series of illustrated bulletins, "How Flange Surface Finishes Affect Gasket Sealability and Joint Performance," published by Johns-Manville discusses the effect of flange surface finishes upon the performance of a gasket. The monograph has been authored by J. W. Axelson and H. H. Dunkle, both specialists in gasket development and application.

Valve Tips

A special 4-page booklet entitled, "Technical Tips," Bulletin 542, by Edward Valves, Inc., describes and illustrates data gathered by the company's laboratories on valve material, installation and usage. Some of the points covered are the effect of heat on valve trim, thermal expansion action of valve materials, the use of globe valves for throttling service, high temperature lubricants for valve studs and bushings and the way creep robs metal strength at high temperatures.

Filming Amines

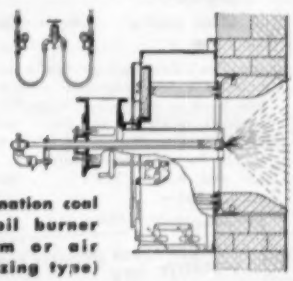
Technical paper No. 129 prepared by W. H. & L. D. Betz Co. and entitled "Film Forming Corrosion Inhibitors Also Aid Heat Transfer" contains many references to the protection afforded by filming amines and mentions the attendant reduction in maintenance costs from this protection.

Enco
OIL BURNERS
have these
7 ADVANTAGES
in pulverized coal fired boilers . . .

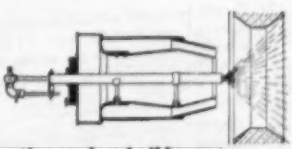
They may be installed in practically all types of pulverized coal burners, with these seven important advantages:

- They warm up cold furnaces
- They ignite pulverized coal—safely
- They assure continuous operation in case coal system fails
- They provide efficient and safe operation on bank and at low loads
- They respond almost instantly to sudden load changes
- They permit operation with oil or coal—whichever is available and lowest in cost per BTU.
- All capacities of steam, air or mechanical-atomizing types are interchangeable

The foregoing are only a few of the reasons why Enco oil-burners have been bought by a long list of leading industrial firms. Details of how Enco oil-burners can be adapted to your present pulverized coal burners will be gladly supplied—without obligation. Write The Engineer Company, 75 West St., New York, N. Y.



Combination coal and oil burner (Steam or air atomizing type)



Combination coal and oil burner (Mechanical atomizing type)

Enco Burners

Turbine Oil Conditioner

A line of oil conditioners with capacities from 40 to 900 gal per hr has been developed by the U. S. Hoffman Machinery Corp. and bulletin A-985 has now been released to describe this equipment and analyze how it meets the problem of conditioning turbine oils.

Metering Tube

The 16-page engineering bulletin, 115-L3, published by Builders-Providence, Inc. on its Dall Flow Tubes describes a new short differential-producing metering device that is said to have the lowest permanent loss of head of any known velocity-increasing differential producer. The bulletin gives information on recovery characteristics, accuracy, applications, range, flow formula, laying length and working pressure of the device.

Refractory Concrete

A basic 16-page booklet entitled, "Refractory Concrete Manual," now available from the Lumnite Div. of the Universal Atlas Cement Co. describes a material that can withstand temperatures of 2600 F and more. Recommended practices on mixing and placing refractory concrete are advanced. In addition sections are devoted to the special properties of the refractory concrete, aggregates, refractory insulating concrete and structural designs.

Cast Stainless Alloys

The Alloy Casting Institute, technical association of high alloy foundries, has just published a set of data sheets covering the properties of all the more popular grades of alloys used for corrosion resistant castings. The publication consists of thirteen data sheets describing each of the cast corrosion resistant grades and is bound under one cover. Each data sheet lists chemical compositions, physical properties, mechanical properties and a discussion of design considerations.

Water-Cooled Television Lens

A special bulletin release, Catalog E.52, by the Radio Corporation of America describes its new water-cooled television lens. Material is furnished on the application, installation and specifications of the lens and its companion industrial television camera. A schematic drawing of a typical installation and a photograph of a lens mounting are included.

Transmission Belt

Raybestos-Manhattan, Inc. have presented their new concept of belt power

transmission, the Poly-V drive, in a new brochure, No. 6638. The design characteristics of the single, endless belt with molded lengthwise ribs are explained and fourteen specific advantages listed.

Water Testing

A new 12-page bulletin, "Testing Equipment for Control Water Analyses," released by W. H. & L. D. Betz Co., has been designed as a guide in the selection of water testing equipment. It describes the company's complete line of titration test stands; test sets for hardness, alkalinity, chloride, sulfites and other materials; specific conductance measuring devices; colorimetric comparators; photometers for water analyses.

Boiler Baffles

The latest data on modern boiler baffles feature the new 20-page Bulletin, BW-54, just issued by the Engineer Co. More than thirty boiler-setting plans are shown, with an analysis of how each arrangement of tubes is baffled to meet, in each case, the specific boiler design. The material given covers every basic boiler construction and numerous variations of each design.

Steam Turbine Trends

Trends like the development of close-coupled cross compound turbines for large capability applications; the rapid increase in size of available 3600-rpm tandem machines; and the widespread application of reheat for improved turbine performance are the subject of the publication, 03R8182, "Today's Trends and Tomorrow's Turbines" available on request from Allis-Chalmers Mfg. Co. This material is a reprint from the *Allis-Chalmers Electrical Review*.

Liquid Level Gages

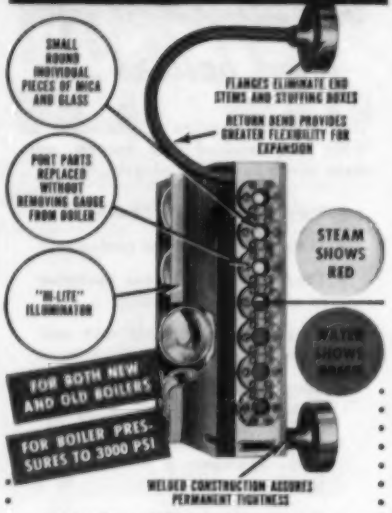
The 8-page Catalog No. 246, Jerguson Gage & Valve Co., covers in detail the three standard types of the manufacturer's convex-scale and float-scale remote reading gages. Features supplied embrace design and construction, product description and schematics, as well as illustrations of typical installations.

Bonding Mortar

Two types of high-temperature, cold-setting bonding mortars—Harwaco Bond and Thermolith—are described in two bulletins of the same name made available by the Harbison-Walker Refractories Co. Harwaco consists of hard calcined high-alumina minerals and plastic bonding constituents while Thermolith is made of finely ground chrome ore, chemical binders and a plasticizer.

NEW

DIAMOND "MULTI-PORT" Bi-Color Gauge


SMALL ROUND INDIVIDUAL PIECES OF MICA AND GLASS
FLANGES ELIMINATE END STEMS AND STUFFING BOXES
RETURN BEND PROVIDES GREATER FLEXIBILITY FOR EXPANSION
PORT PARTS REPLACED WITHOUT REMOVING GAUGE FROM BOILER
STEAM SHOWS RED
"HI-LITE" ILLUMINATOR
WATER SHOWS GREEN
FOR BOTH NEW AND OLD BOILERS
FOR BOILER PRESSURES TO 3000 PSI
WELDED CONSTRUCTION ASSURES PERMANENT TIGHTNESS

"MULTI-PORT" Advantages:

(1) "Bi-Color" principle shows steam red and water green
(2) Small round ports instead of long glass strips
(3) "Hi-Lite" illuminator for improved visibility
(4) Simplified high-pressure construction
(5) Maximum thermal stability for rapid starting
(6) Easy, inexpensive maintenance . . . in place
(7) Direct reading . . . basic reference gauge

The "Multi-Port" gauge has been developed over a four-year period and has been in continuous successful high pressure operation for more than 18 months in several leading central station plants. For additional information, write for new Bulletin 1174 . . . use the coupon below.

7004

DIAMOND POWER SPECIALTY CORP. V
LANCASTER, OHIO

Please send me without obligation a copy of new Bulletin No. 1174 explaining the advantages of the Diamond "MULTI-PORT" Bi-Color Gauge.

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COMPANY_____
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DIAMOND POWER SPECIALTY CORP.
LANCASTER, OHIO
Diamond Specialty Limited—Windsor, Ont.

Strainers and Relief Valves

Catalog Section 12-T, Edward Valves, Inc., is an 8-page publication on relief valves and strainers and also includes newly designed union bonnet strainers in sizes from $1^1/_4$- to 2-in. Dimensions, design details and installation and maintenance tips are provided.

Proportioning Pump

The 6-page, Bulletin AP-54, Hills-McCanna Co., describes the company's new proportioning pump with no packing, high speed valves and pulse-free flow.

Cooling Towers

The Fluor Corp. in a 36-page publication, designated as CT-ID-0.002, explains cooling tower construction and application in detail. The advantages of counterflow designs, methods of water distribution, all components such as framework, sheathing, driving mechanisms, from basin to fan stack are covered.

Product Catalog

A 4-page bulletin, No. 6210, briefly covers the Cochrane Corp. line of water conditioning equipment and specialties. The bulletin lists the individual equipment and provides an identification number for other booklets that give detailed data on the individual equipment.

Pressure Fillers

A well-documented bulletin, No. 2225B, by Permutit Co. describes its line of pressure filters and their accessories. These filters now remove suspended solids such as dirt, turbidity, iron, oil and color. Specifications, operating characteristics, outline dimensions and photographs are furnished.

Tube Expanders

Bulletin Y-38, an 8-page release by Elliott Co., shows a full line of tube expanders for condensers and heat exchangers, and gives data on how to choose the proper expander for the job at hand.

Surface Condensers

A 20-page publication, 19B8201, "Proportioning of Surface Condensing Equipment," by the Allis-Chalmers Mfg. Co. gives the latest data and technical information on the operation, nomenclature, and definitions of surface condensers. Factors entering into the proportioning and selection of surface condensers, formulas for calculating condenser performance, a variety of curves and tables are supplied.

NEW EQUIPMENT

Variable-Speed Drive

A complete redesign of its fractional hp Vari-Speed Motodrive has been announced by the Reeves Pulley Co., Columbus, Ind. The new unit comes in 1/4-, 1/3-, 1/2- and 3/4-hp sizes in speed ranges from 2:1 to 10:1. The new design is said to give a more compact unit available in 112 different assemblies to meet exact space requirements. Included among these assembly variations

are horizontal, vertical and 45 degree models and those with output shafts vertically down with speeds from 3 to 4660 rpm.

A reported added advantage is a threaded, spiral-groove lubrication system. It is said to assure complete coverage of lubricant over all sliding surfaces.

Air Filter

Foxboro Co., Foxboro, Mass., recently announced a new air filter designed to prevent dirt, oil, water and other foreign matter from entering pneumatic instruments. The new filter consists of four major elements: a top cap with supply and outlet connections, a chamber with a drain cock at the bottom, a resin-impregnated filtering sleeve and a water baffle. The filter unit, 4 cfm capacity, has a sump volume of 12 cu in., a filtering area of 21.2 sq in., a maximum working pressure of 150 psi, and measures about 8 1/2 by 4 1/8 in.

Supply air enters through the inlet port, strikes a baffle plate on the cap, enters the chamber, passes through the filter and leaves through the outlet port. Moisture drops to the bottom of the chamber and is easily drained off or blown out through the drain cock. The filter sleeve, of moisture-resistant cellulose, removes particles to 40 microns.

Pipe Insulation

Hot and cold piping from 3/4- to 24-in. diam can now make use of the Gustin-Bacon Mfg. Co., Kansas City, Mo., Snap-On pipe insulation which is a one-piece molded-pipe insulation of glass fibers. It serves all chilled and refrigerated lines and any heated lines that do not exceed 350 F.

This product comes in 3- and 6-ft lengths depending on pipe size. Small pipe sizes, up to 2-in. diam., use 3-ft lengths. Wall thicknesses of 1/2-, 3/4-, 1- and 1 1/2-in. are available in sizes up to 12-in. diam while 1-, 1 1/2- and 3-in. wall thicknesses are furnished for pipes above 12-in. diam. Highlight feature is a reported K factor of 0.23 at 100 F mean temperature.

Power Relay

The Autronic Type P2R power relay is claimed by its manufacturer, The Swartwout Co., Cleveland, Ohio, to eliminate transmission lags characteristic of all-pneumatic control systems.

The new design is an electro-pneumatic transducer designed to work with the manufacturer's Autronic Control. It takes the electrical output from the controller and converts it to an air-loading pressure proportional to the electric current. Process variables are converted into a small ac voltage by the primary element transmitter and acted upon by a selective wide range of control actions.

Volt-Ammeter

New hook-on volt-ammeter, the AK-5, believed to be the first with automatic scale changing, has been developed by the General Electric Co.'s meter and instrument department. It is pocket-size and designed to measure current and voltage quickly and accurately. There are four ampere ranges, 5/20/80/350 amperes, and three ac voltage ranges, 150/300/750 volts, without auxiliary equipment. Measurements are within 3 per cent accuracy. The desired range and scale is obtained by turning the unit's switch knob.

Water Column Gage

Over a four-year period of development has been spent in perfecting the Multi-Port gage for water level indication in high pressure boilers up to 3000 psi according to its maker, the Diamond Power Specialty Corp., Lancaster, Ohio.

Principal features are: (1) very much lower maintenance because of simplicity of construction and rapid and easy replacement of the elements; (2) greater

pressure and thermal stability with small, round ports; (3) easy handling since gage only weighs about 58 lb including flanges; (4) excellent readability since ports stand out as brilliantly colored beacons—green is water; red, steam; and water level is always where colors meet.

Pipe Strainers

A new line of cast, semi-steel, Y-type pipe strainers recently announced by Armstrong Machine Works, Three Rivers, Mich., are for use in steam, air, water, oil and gas lines at pressures to 250 psi. There are eight sizes from 1/4- through 2-in.

High Pressure Valves

Newest addition to high pressure control valve line manufactured by the Annin Co., 6570 E. Telegraph Rd., Los Angeles 22, Calif., is the series 34 valves for pressures up to 6,000 psi and temperatures up to 900 F. Models are available for motor operation cylinder or manual. Valves come in sizes 1/8-in. and 3/4-in. in a wide selection of body and trim materials in both offset globe and angle bodies.

Gas Scrubber

Liquid precipitating stack gas scrubber developed by Johnson-March Corp., Philadelphia, Pa., for installation in low-cost housings of cinder block, concrete or fabricated steel comes in eight models that can handle high temperature gases in capacities

ranging from 8000 cfm to 60,000 cfm. About 2½ gal. of water per minute at 40 to 50 psi are needed per 1000 cfm. The equipment is particularly suited for stack dust from kilns, roasters, mixers, sintering plants and similar industrial installations.

Emergency Light

Automatic standby, emergency light, Model 116, supplied by the Carpenter Mfg. Co., Boston 45, Mass. conforms to the latest National Fire Code and is fully UC approved The glass jar (non-automotive type) battery can deliver 91 per cent of rated capacity after thirty minutes of actual use. There are external switches for quick testing and other switches to control the battery charger and disconnect lampheads if the unit is out of service. Visible disk-float hydrometer eliminates any need for ladder climbing.

Instrument Air Drier

A small desiccant air and gas dehydrator designed especially for isolated pneumatic equipment has recently been developed by Hankinson Corp., 146 Biltmore Bldg., 951 Banksville Rd., Pittsburgh 16, Pa. Rated at 1 scfm at 100 psig and 70 F the Dehydrafilter features a disposable desiccant cartridge and "O" ring seal construction that eliminates any tools to remove or change the cartridge.

Strainer Trap

A large model integral steam trap, No. 882, has been added to the line of Armstrong Machine Works, Three Rivers, Mich. It is said to cost less than a standard trap plus separate Y-strainers and require less fittings to install. The stainless steel strainer screen sets in the body casting at the bottom of the trap. Internal parts of the trap itself are chrome steel and stainless. Model 882 has horizontal and opposite pipe connections of ½- or ¾-in. size with capacity ranges from 1300 to 2200 lb per hr of condensate.

Excitation System

An inductor alternator substituting for the usual dc machine gives an entirely new exciter system for (1) modernization of older generations or for (2) inclusion with new units, according to Allis Chalmers Mfg. Co., Milwaukee 1, Wis. The heart of the system is the 360-cycle inductor generator which has no windings, commutator or slip rings. Power for excitation is generated at high frequency and then changed to dc by a bank of selenium recifiers. The rotating element of the ac exciter is adaptable to overhung mounting on most 3600 rpm generators thereby eliminating case couplings, gears and exciter bearings.

Centrifugal Blower

Large volume, standard production centrifugal blower developed by the Air Appliance Div., U. S. Hoffman Machinery Corp., 105 Fourth Ave., New York, N. Y., employs three interchangeable impellers that permit a factory assembly to give any air volume between 2000 and 9000 crm with pressures ranging from 1 psig to 9 psig or vacuum from 2 to 12-in. Hg.

Liquid Level

Closed tank liquid level measurements either under a pressure or a vacuum, can be performed with a differential converter, just announced by the Industrial Div., Minneapolis-Honeywell Regulator Co., Wayne & Windrin Aves., Philadelphia 44, Pa. The instrument uses a pneumatic balance, weigh-beam system readily adjustable in the field for applications from 0–14 to 0–200 in. of water.

WANTED

a power plant man who wants to cash in on his experience

Responsible, good-paying positions now open in established territories in the East and Middle West. Salary plus commission and expenses. Profit-sharing, group insurance, pension plan, paid vacations and sickness benefits.

If you have a practical, mechanical power plant operation background and are 30 or older, we'd like to tell you about how we will thoroughly train you as a

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Do you qualify? Are you interested? If so, then write or phone for a confidential interview.

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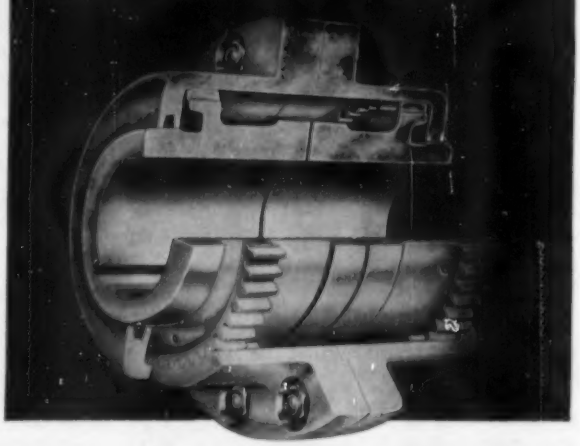
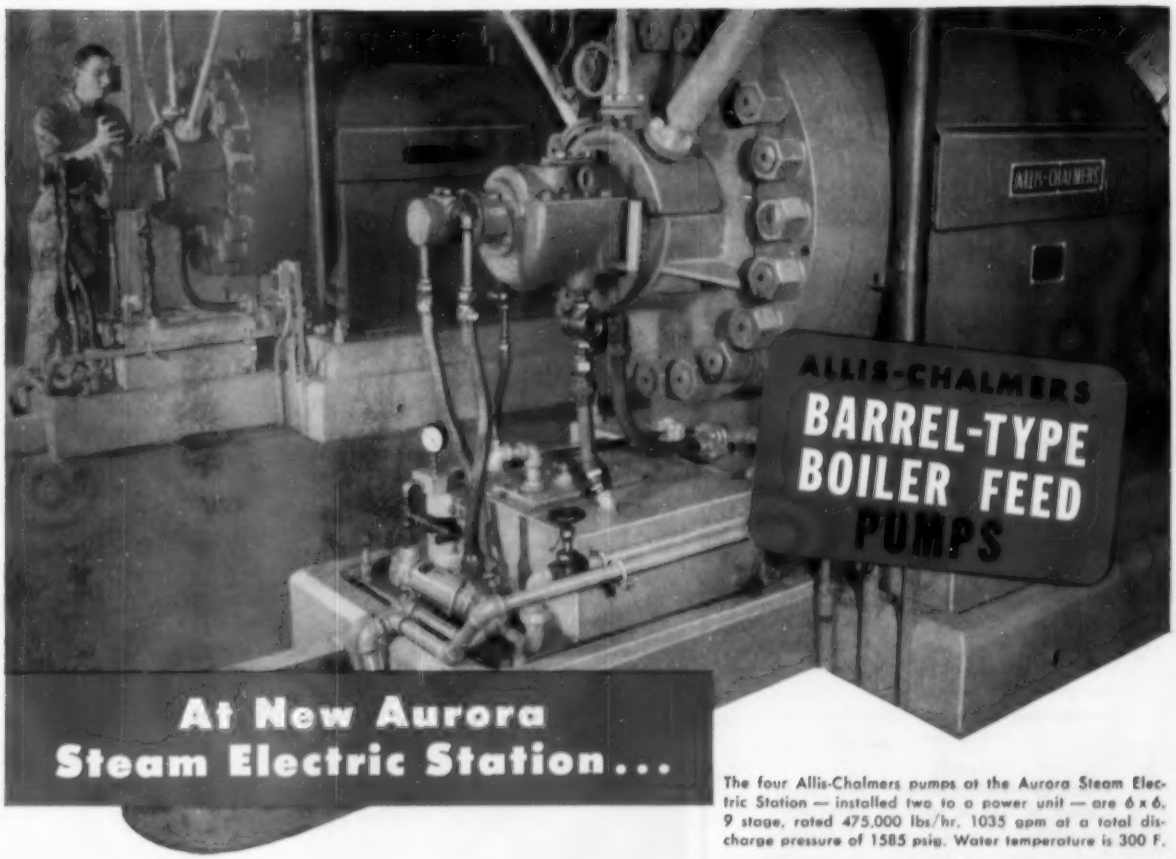


A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY WOODBERRY, BALTIMORE, MD.



At New Aurora Steam Electric Station...

The four Allis-Chalmers pumps at the Aurora Steam Electric Station — installed two to a power unit — are 6 x 6, 9 stage, rated 475,000 lbs/hr, 1035 gpm at a total discharge pressure of 1585 psig. Water temperature is 300 F.

Minnesota Power & Light Installs 4 of these Highly Reliable Pumps

THE NEW 88,000-KW AURORA STEAM ELECTRIC PLANT at Aurora, Minn., is a model of modern design and efficiency. Equipment was carefully chosen for its ability to provide extra dependable, low-cost operation.

On this basis Minnesota Power & Light Co. — working with its consulting engineers, EBASCO SERVICES INCORPORATED — bought four Allis-Chalmers barrel-type boiler feed pumps.

WHAT ARE YOUR PUMP NEEDS?

Whether you require boiler feed, condensate, circulating or other power plant pumps — a careful study will reveal why more and more utilities are specifying Allis-Chalmers. Check the design features, the operating advantages, the provisions that make a pump easier to maintain, or service. You, too, will find it pays to standardize on Allis-Chalmers Power Plant Pumps.

ONE SOURCE FOR THE ENTIRE UNIT

Allis-Chalmers can supply the complete unit of pump, motor and control — all of coordinated design and manufacture. And you get one responsibility, one reliable guarantee of satisfaction covering the whole unit. A-4407

For detailed information, call your A-C district Office or write Allis-Chalmers, Milwaukee 1, Wisconsin. Ask for bulletin 08B7899.

ALLIS-CHALMERS

Now watch combustion conditions every minute of the day

. . . with RCA Industrial TV

With RCA's new water-cooled window—you maintain continuous observation of flame conditions and ignition—*at the control panel*—24 hours a day. High-detail picture eliminates the need for periodic observation of furnace and checking burner operation.

Water-cooled window can be installed at top of furnace to observe tangential firing—in side of furnace to observe direct firing. High-capacity blower and pump unit can serve two windows.

HERE'S THE ANSWER to continuous, low-maintenance, fail-safe observation of furnace conditions . . . high-detail RCA Industrial TV (ITV-5A) and the new RCA water-cooled window.

By using a high-efficiency circulating system, RCA has reduced lens temperatures at the camera below 120° F—for stable, dependable camera operation.

The RCA Industrial TV water-cooled window is a reliable tool for use by your operators for continuous remote observation of combustion conditions. RCA now offers this new revolutionary equipment as a complete, engineered package to power plants—plus installation and maintenance service.

FOR INFORMATION on RCA Industrial TV (Type ITV-5A), write Radio Corporation of America, Dept. K-187, Building 15-1, Camden, New Jersey.

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RADIO CORPORATION of AMERICA

ENGINEERING PRODUCTS DIVISION *CAMDEN, N. J.*

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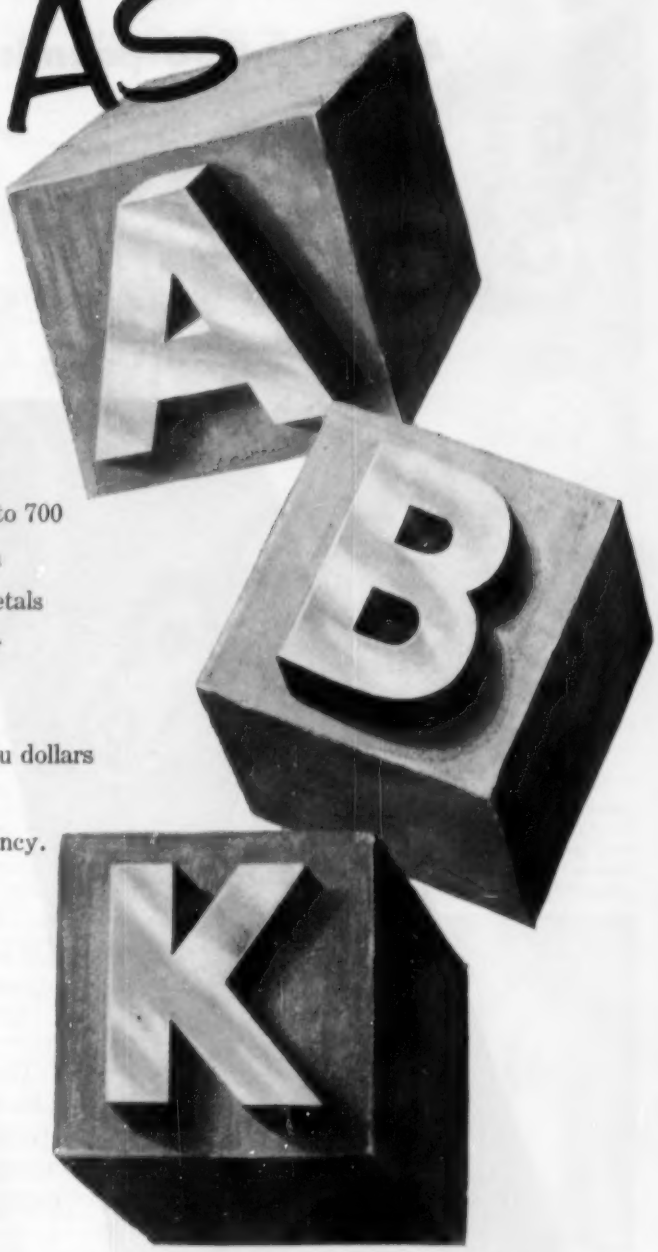
SIMPLE AS



Getting profitable life from castings which must face heavy abrasive service is simple as A B K.

ABK Metal castings stand up better and last longer because of carefully controlled metallic structure and specified hardness (500 to 700 Brinell). Because ABK Metal has those extra qualities that ordinary "abrasion resistant" metals lack, you can expect up to seven times greater service from ABK Metal castings.

The extra life of ABK Metal castings saves you dollars both in replacement parts and labor—cuts downtime, increases your operating efficiency. Let us show you how ABK Metal, an exclusive Brake Shoe product, can solve your abrasive wear problems.

2166

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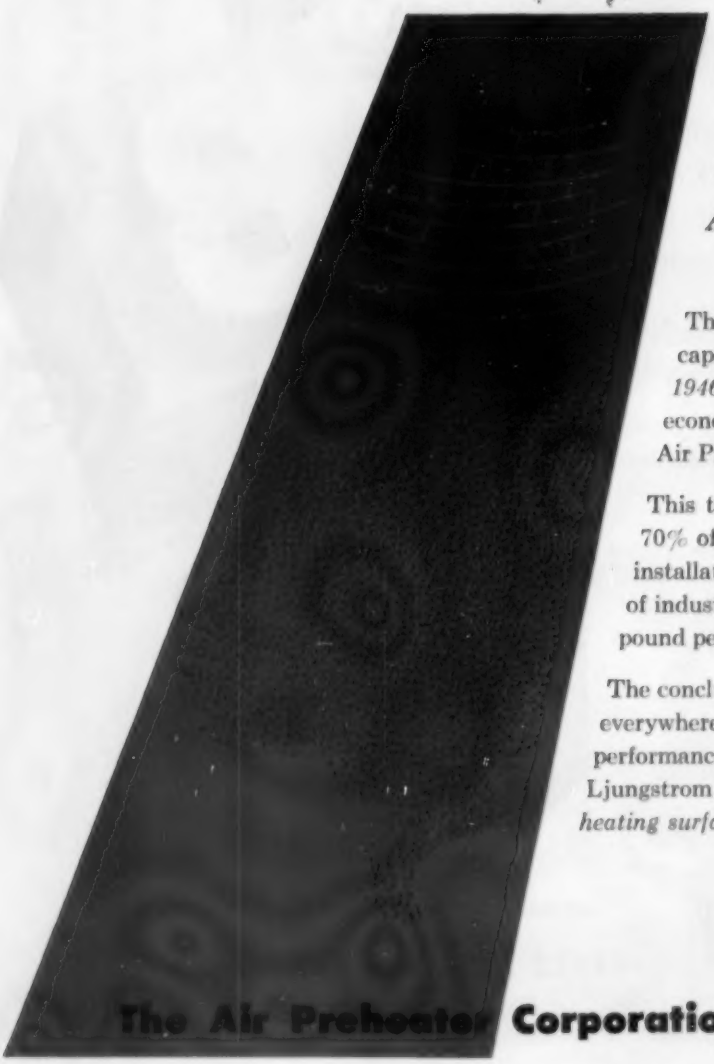
BRAKE SHOE AND CASTINGS DIVISION

230 Park Avenue, New York 17, N. Y.

420,000,000 pounds of steam per hour



served by

LJUNGSTROM

Air Preheaters

That's the amount of new steam capacity, installed or on order *since 1946 alone*, designed to utilize the economies available with the Ljungstrom Air Preheater.

This total capacity includes nearly 70% of all new central station boiler installations, as well as the major portion of industrial boilers in the over-250,000 pound per hour range.

The conclusion is obvious: Boiler users everywhere realize that the fuel-saving, performance-boosting abilities of the Ljungstrom make it the *most economical heating surface on the modern boiler.*

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

The most widely used high temperature block insulation for over a quarter century...

SUPEREX® high temperature block insulation has long been industry's No. 1 choice for service temperatures up to 1900F. It provides *major* economies . . . reduces fuel costs, cuts heat losses, keeps maintenance expense down, costs less to install and has long service life.

These are the reasons why 90% of the nation's hot blast stoves are Superex insulated . . . and why the low cost open hearth steel producers use Superex in their regenerators.

Made of specially selected and calcined diatomaceous silica blended with other insulating materials and bonded with asbestos fiber, Superex will safely withstand temperatures up to 1900F with negligible shrinkage.

Superex has been used with outstanding success in all types of industrial and metallurgical furnaces and ovens, stationary and marine boilers, auxiliary power plant equipment, regenerators, kilns, roasters, high temperature mains, flues and stacks.

Superex has all these important advantages...

Low thermal conductivity—Exceptionally high heat resistance (1900F) combined with excellent insulating value.

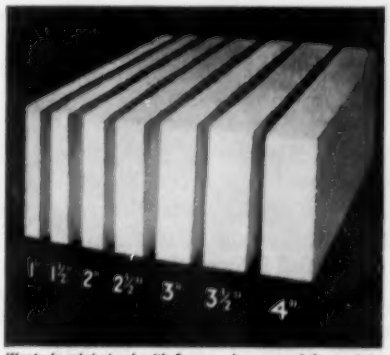
Light weight—Approximately 2 lb per sq ft per in thickness.

Great physical strength—Approximately 6 tons pressure per sq ft are required to compress Superex ¼ in.

Long, efficient service life—Superex maintains high insulating value indefinitely—will not disintegrate in the service for which it is recommended.

Fast, easy application—Superex may be cut with an ordinary knife or saw for fitting around openings or to irregular surfaces. Because of its light weight and convenient sizes, Superex assures fast and economical installations.

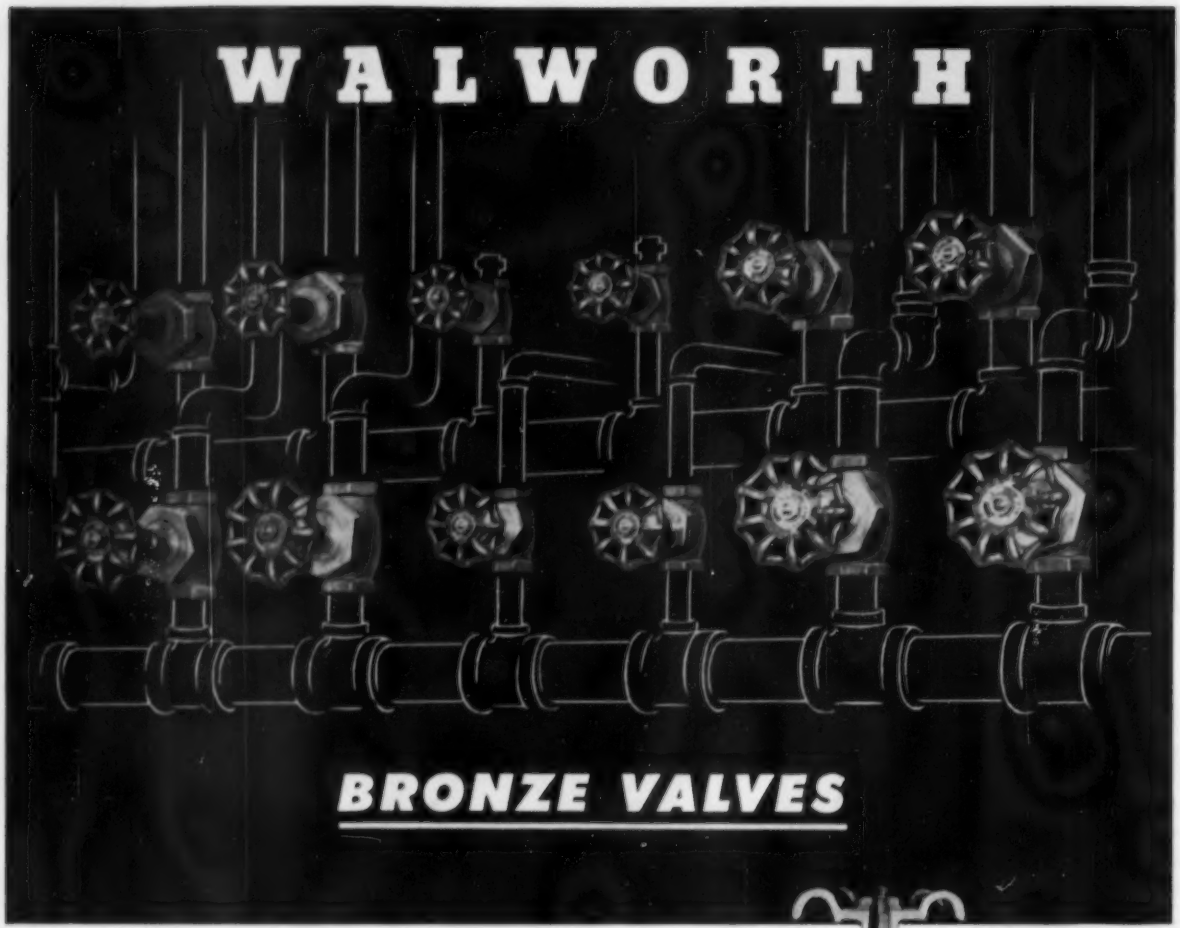
For complete information about Superex block insulation, write for Brochure IN-134A. Address Johns-Manville, Box 60, New York 16, N. Y. In Canada, write 199 Bay Street, Toronto 1, Ontario.



Waste is minimized with Superex because of the variety of thicknesses available. Special shapes and intermediate thicknesses between those shown are also available.

JOHNS MANVILLE JM PRODUCTS **Johns-Manville** *first in* **INSULATIONS**

WALWORTH



BRONZE VALVES

Better because ... **Walworth has standardized its line of bronze valves to provide an unsurpassed system of interchangeability of parts for assembly or replacement. You can maintain a great number of Walworth Bronze Valves with a small inventory of basic parts ... you minimize part replacement problems. For further information, ask us for our Bronze Valve Standardization Chart.**

Parts are carefully machined and finished to close tolerances, thereby assuring accurate fit and alignment under all conditions. Sectioned valve is Walworth No. 225P Bronze Globe Valve with stainless steel plug-type seat and disc, heat-treated to a minimum of 500 Brinell hardness.

Choose from complete lines of Walworth Bronze Valves – including gate, globe, angle, check, and lubricated plug types. Walseal® Bronze Valves and Fittings are also available for making silver-brazed joints.

For full information on Walworth Bronze Valves and Fittings, call your Walworth Distributor, nearest Walworth Sales Office, or write to Walworth Company, General Offices, 60 East 42nd Street, New York 17, N. Y.

WALWORTH

Manufacturers since 1842

valves ... pipe fittings ... pipe wrenches

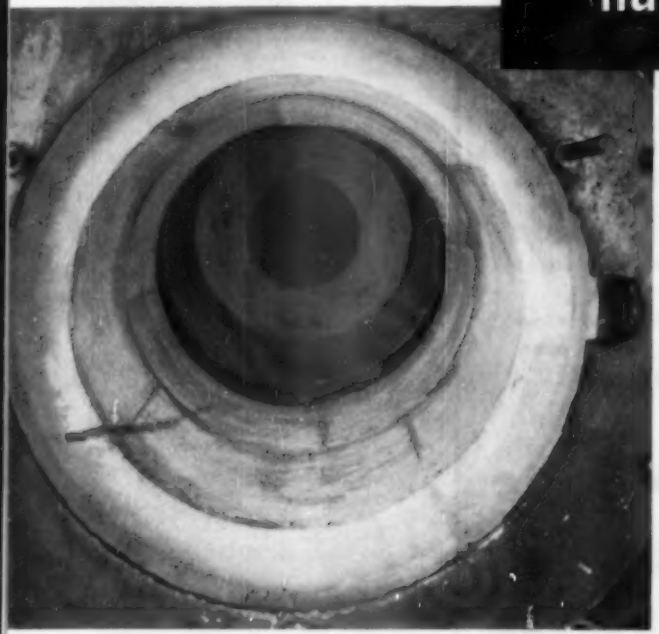
60 East 42nd Street, New York 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

Which of these boiler problems do YOU have?

❶ **SPOTS EXPOSED TO ABRASION** and heat shock pose king-size problems. These grate blocks, for example, are subjected to extreme heat, clinkers, slag, and shock induced by cooling air. With certain coals and types of service, these conditions become really destructive. About the only material to take this beating is CARBORUNDUM's silicon carbide. It doesn't soften, and is not prone to spall and crack. Is this the refractory to lick some of your trouble spots?

❷ **SLAG AND FLAME EROSION** play havoc with refractories. And here's an example of both . . . at their worst! Pulverized coal burner rings are exposed to direct flame, to a blast of razor-sharp particles, and to molten slag. Under these conditions the average refractory softens, spalls, and cuts out. Slag builds up and spoils the flame pattern. All this is *what doesn't happen* with rings of CARBORUNDUM's silicon carbide. So, if you have these problems . . . which refractory?



❸ **HIGH HEAT RELEASES** in confined spaces require top protection for metal surfaces. And the best refractory to meet these conditions is CARBORUNDUM's silicon carbide. Within seconds of firing, this combustion chamber liner becomes uniformly hot. This prevents heat-shock cracking, and the heat is transmitted rapidly. The liner stays hard, and forestalls carbon build-up. So, if you want to be sure—which refractory would you pick?

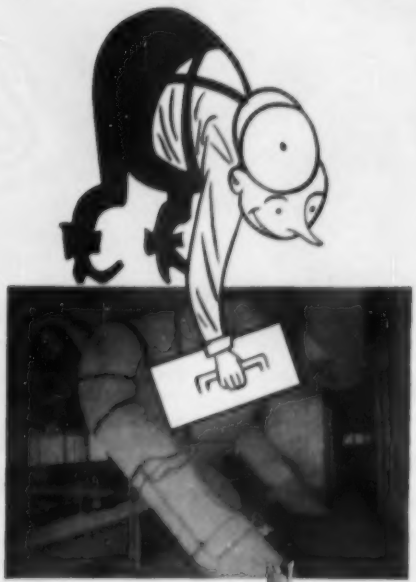
❹ **FURNACE DOWNTIME** is highly expensive. With the loss of idled productive capacity; with current sky-high maintenance costs; with material replacement expense . . . even the best, the most costly refractories, are cheap by comparison. That's why we urge you to look into CARBORUNDUM's silicon carbide refractories, trade-marked CARBOFRAX®. Put them in the most troublesome spot in your boiler. See for yourself how they solve *that* problem.

As an introduction, get a copy of "Super Refractories in Boiler Furnaces". No obligation, of course. Send your name and address to Dept E-114 Refractories Div., The Carborundum Company, Perth Amboy, N. J.

CARBORUNDUM

Registered Trade Mark

Save With This Matchless
ONE-COAT SUPER FINISH



Cement . . .
A Light, Efficient Insulation

- *Easiest to Apply*
- *Adhesive*
- *Maximum Coverage*
- *Smooth, White Finish*
- *Hard* ● *No Cracking*
- *Resistant to Abrasion and Water*
- *Ready to Paint or Weathercoat*

Use One-Coat Super Finish Stic-Tite on flanges, valves, fittings, flat or curved surfaces of boilers, fans, tanks and other equipment, whether indoors or exposed to the elements.

Save with R & I Super Finish Stic-Tite—the insulating cement that goes further—lasts longer. 100 lbs. covers 80 sq. ft.—⅓" thick, or 160 sq. ft.—¼" thick. Can be easily troweled smooth in ONE COAT directly on block, blankets or metal surfaces, air-drying quickly without shrinkage or cracking.

One-coat application saves time and labor.

Super Finish Stic-Tite is low in material cost, low in overall cost, long lasting.

R&I

SUPER FINISH STIC-TITE

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MAINTAINING BOILER STATUS QUO

Inside a boiler, you can't improve on new steel — or steel newly cleaned. All you can hope to do is keep it that way—a task that often tries every known resource of boiler operation and maintenance.

Against the metal-destroying forces that can be unleashed inside steam-generating pressure vessels, there is one unique defense—unique because *nothing else duplicates* its service inside a boiler.

Apexior Number 1, the brush-applied boiler coating, ends water-metal contact—isolates new or newly cleaned steel beneath a surface immune to corrosive action and resistant to operating deposits. It stays on the job thereafter, without benefit of human or mechanical attention, to hold internal surfaces at peak steaming efficiency.

Maintaining boiler status quo is an assignment Apexior has carried out successfully now for thirty-six years for those who design, insure and operate every type of industrial and central-station power plant.

You pay even *less* today to protect the boiler that costs so much *more* to install and operate. Apexior Number 1 is now a *one-coat* material. You need less . . . it costs less to apply.

Internal boiler protection is only one of Dampney's diversified corrosion-control activities. Dampney Coating Systems for specified end-use service protect cooling towers—intake water structures—pipeline interiors. For a recommendation to meet your requirements, write

MAINTENANCE FOR METAL

THE DAMPNEY COMPANY

HYDE PARK, BOSTON 36, MASSACHUSETTS

Stability of Performance on the job

CLARAGE
TYPE NH, CLASS II-A
FORCED DRAFT FANS

dependable **BROAD** efficiency, rather than S^H^A^R^P peak efficiency

No tendency toward unstable, unpredictable performance!

With the Clarage Type NH Fan you get efficiency where it counts: under actual operating conditions. Modern manufacturing techniques assure that each of these fans is accurately constructed to perform according to its rating and in line with its advanced design.

As fully described in Bulletin 802, Type NH, Class II-A forced draft fans are provided with independent bearing pedestals, split type housings, and non-overloading, backwardly inclined wheels (diameters 15" to 66").

Users agree that here is thoroughly dependable equipment fully answering within its performance range the requirements of modern power plants. For heavier duty forced draft service, Clarage fans are available in Classes III and IV construction.

Request Bulletin 802

CLARAGE FAN COMPANY, Kalamazoo, Mich.

You can Rely on... CLARAGE

Headquarters for Air Handling and Conditioning Equipment

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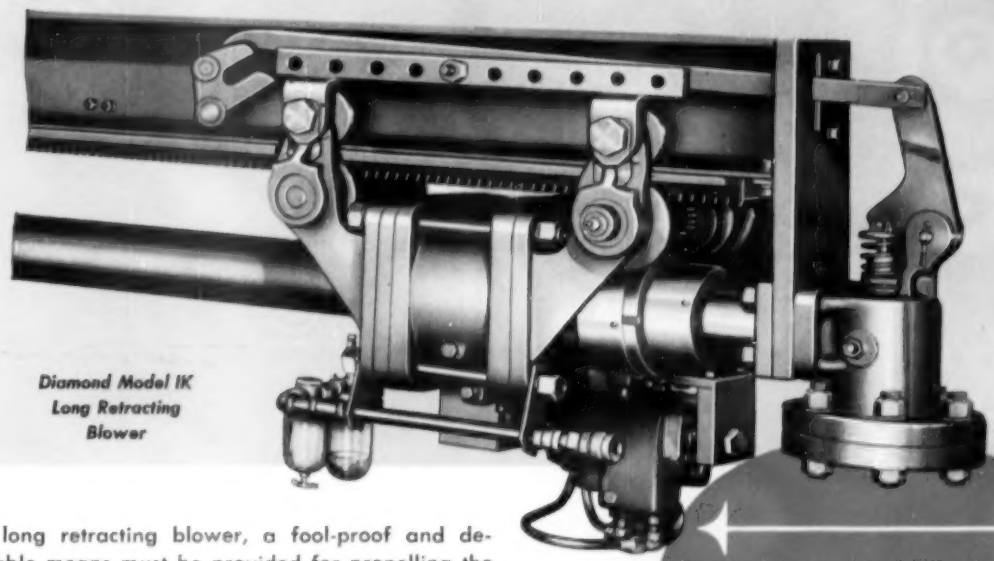
One of a Series

Reasons Why DIAMOND BLOWERS Assure CLEANER BOILERS *at LOWER COST*

SINGLE MOTOR DRIVE



Diamond Model IK Long Retracting Blower

A Single Motor (air or electric) Both Rotates and Propels the Long Lance Tube

In a long retracting blower, a fool-proof and dependable means must be provided for propelling the carriage and rotating the lance tube. In Model IK it is done with a SINGLE MOTOR working through a simple system of rugged gears. The operating mechanism is a model of simplicity and reliability . . . only one set of motor elements, one set of control elements . . . one set of power supply facilities to operate and maintain. This drive produces a closely pitched helical cleaning pattern which is most effective for *all* deposits and tube banks . . . without tube cutting.

Other features which users approve with enthusiasm are the mechanically operated valve with adjustable pressure control, and the positive gear drive. Ask for Bulletin 1080V.

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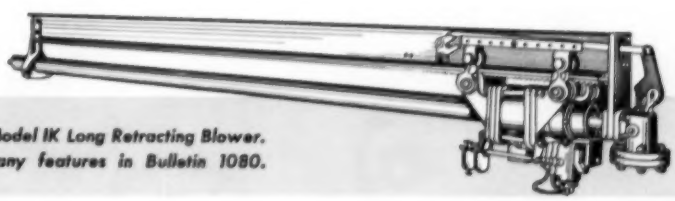

Diamond Model IK Long Retracting Blower. See its many features in Bulletin 1080.

40 PAGES of helpful information

on Recovering Dusts, Fly Ash, Mists, Fumes and other Suspensions from Gases.

This booklet summarizes

the important points design and plant engineers should know about Cottrell Precipitators . . .

- Basic types of Cottrell equipment.
- Principal elements in a Cottrell unit.
- Data on Mechanical and Electronic Rectifiers.
- Various types of Collecting Electrodes (rod curtains, corrugated plates, pocket electrodes, etc.).
- Typical ways of removing collected material.
- Various Shell Constructions (steel, concrete, brick, etc.).
- The effect of various factors on efficiency and performance.
- Data on CMP (Combination Multiclone-Precipitator) Units.

. . . and many other helpful facts on Cottrell design and operation.

Latest data from Western Precipitation on Cottrell Recovery Equipment

Do you have operations in your plant where gas-laden suspensions, wet or dry, are a problem? Such suspensions may be dropping on surrounding property, causing nuisance difficulties. Or perhaps important values are being lost in stack gases that can be profitably recovered. Whatever the nature of your recovery requirements, you will find this 40-page Cottrell booklet of great help. It contains up-to-date data on the latest advancements in the electrical precipitation field – prepared by the organization that pioneered the commercial application of Cottrell Electrical Precipitators almost a half century ago and has consistently led in new Cottrell developments.

A copy of this data-packed booklet will be sent free to engineers and other executives interested in recovery processes. Send your request to our nearest office.

For nearly 50 years Western Precipitation has carried on a continuous research and development program on Cottrell Electrical Precipitators, Multiclone Mechanical Collectors and other types of recovery equipment. We are not affiliated with any other company in the electrical precipitation field except our wholly owned subsidiaries, International Precipitation Corporation and the Precipitation Company of Canada, Ltd. We are equipped to serve you anywhere in the United States, Canada, and throughout the world!

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